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NEW SERIES, VOLUME XV

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The American Journal of Surgery

NEW SERIES, VOL. XV

JANUARY, 1932

No. 1

TRIBROMETHANOL-AMYLENEHYDRATE (AVERTIN FLUID)*

REPORT OF 314 BASAL ANESTHESIAS ADMINISTERED TO 225 PATIENTS

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NEW HAVEN, CONN.

SINCE April, 1930, tribromethanol in amylenehydrate has been employed in the New Haven Hospital for the purpose of producing basal anesthesia in 251 surgical procedures and in the treatment of 2 cases of tetanus and one of chorea.

TYPES OF OPERATIONS

The operations in which basal anesthesia was induced are shown in Table I. Tribromethanol-amylenehydrate was used particularly in operations in which a long period of surgical anesthesia was desired. Because of the convenience of administration,^{17,22} it was also employed in 53 operations about the head and face. The longest operation, an unusually complicated craniotomy, required six hours and forty-five minutes, the shortest, a tonsillectomy, about fifteen minutes, the average time was one hour and forty-seven minutes.

AGE AND SEX

The age of the patients, of which 62.6 per cent were females, varied from two to seventy-three years (Table II).

TABLE I

TYPES OF OPERATIONS

I. Operations on the cerebral cranium, spinal column, and their contents:	27
a. Craniotomies.....	10
b. Laminectomies.....	9

TABLE I (Continued)

c. Albee bone graft of spine.....	2
d. Amputation of coccyx.....	1
II. Operations on the visceral cranium:	53
a. Antrostomies, submucous resection, adenoidectomies and tonsillectomies, resection of septum, etc.....	39
b. Trigeminals or infra-orbital neurectomies.....	3
c. Neoplasms of tongue, cheek, lip.....	3
d. Dressing of scalp wound.....	1
e. Suturing wound, extraction of tooth..	1
f. Mandible wired and wife removed....	2
g. Extraction of molar.....	3
h. Excision of salivary calculus.....	1
III. Operations on the neck:	29
a. Subtotal thyroidectomies; excision of thyroid cysts.....	26
b. Excision lymph gland of neck.....	2
c. Cervical sympathectomy.....	1
IV. Operations on the chest:	20
a. Bronchoscopies.....	3
b. Lipiodol injections, bronchi.....	1
c. Esophagoscopy.....	1
d. Breast amputation.....	3
e. Skin graft.....	1
f. Thoracoplasties; thoracotomies; osteomyelitis of clavicle.....	9
g. Cardiolytic.....	2
V. Operations in the abdomen, pelvis, etc.:	89
a. Exploratory laparotomies.....	10
b. Hernia and exploratory laparotomy...	1
c. Inguinal hernias.....	10
d. Appendectomies.....	4
e. Cholecystectomies.....	4
f. Appendectomy and cauterization of cervix.....	1
g. Gynecological laparotomies.....	27
h. Cesarean section.....	1
i. Nephrectomies; removal of renal calculi.....	11
j. Suprapubic cystotomy.....	1
k. Therapeutic abortion.....	1

* From the Department of Surgery, Yale University School of Medicine. Submitted for publication October 26, 1931. The expense of this investigation was defrayed by the Winthrop Chemical Company.

TABLE I (Continued)

I. Bladder tumor excision	1
m. Dilatation and cauterization of uterus	13
n. Prostatectomies	3
o. Hemorrhoids	1
VI. a. Operations on the extremities:	6
b. Tiebolt sacroiliac	2
c. Exploration of thigh	1
VII. Tetanus	2
VIII. Chorea	1
Cases	225

TABLE II

AGES OF PATIENTS

Age	Per Cent of Cases
2-14	11
15-24	13
25-33	16
34-60	51
61-73	9

INDICATIONS AND CONTRAINDICATIONS

The introduction of tribromethanol was preceded¹¹ by a review of the German literature and a communication with practically all of the chief surgeons of the teaching institutions in Germany, Austria, Switzerland and Checkoslovakia, in which countries tribromethylalcohol has been in use since 1926.*

Parenchymatous damage of the liver and extensive bilateral kidney disease are the only contraindications to tribromethanol basal anesthesia on which there is a general agreement. In such cases any type of basal or general anesthetic is contraindicated; therefore great caution is warranted with a drug whose eliminatory process is unknown in its details. This anesthesia was used with gratifying results in cachectic patients, in individuals with pulmonary tuberculosis, and in patients with one kidney so damaged as to require nephrectomy. A basal anesthesia is particularly indicated in hyperthyroidism (see also Klose,¹⁶ Pribram¹⁹), because thereby the psychic shock and excitement are reduced to a minimum, and there is complete amnesia. These are most welcome and aid materially in the favorable outcome. According to Anschuetz,¹ Cushing⁵

and Dandy,⁶ particular advantages can be observed in intracranial operations. This has been also our experience in ten craniotomies.¹²

PRELIMINARY MEDICATION

As a rule a cleansing enema was given in the evening preceding the day of operation. This, however, seems not absolutely necessary, since in a number of patients operated on soon after admission no difference was observed in either the rapidity of the action of tribromethanol or in the degree of anesthesia. This was previously observed by Blume,² Gallinek,¹⁰ Enke and Westphal⁹ in psychiatric cases, and in patients with serious injuries or burns (Ebhardt⁸), where there was no time for a cleansing of the bowels.

In 42.2 per cent of our cases a hypnotic was given the evening before operation. Luminal was administered to more than a third; the rest received veronal, bromides, chloral hydrate, morphine, codein, amytal, allonal, pantopon, or paraldehyde in amounts that are usually given to produce sedation. In the few failures to obtain satisfactory basal anesthesia, three patients belong in the group that did not receive a sedative or hypnotic the evening preceding operation.

Experience has shown that tribromethanol-amylenehydrate, administered in sufficient dosage, produces satisfactory basal anesthesia and that a combination with other hypnotics is not required to obtain such an effect. However, a sedative or hypnotic is, of course, given when it is necessary to quiet the patient, relieve pain, or produce sleep on the night or day prior to operation.

A controversy has also arisen regarding the desirability of administering a hypnotic or sedative prior to the avertin enema, on the day of operation. Eiselsberg, Bernhard Martin, and Clairmont definitely object to it.¹¹ In our series, 14 per cent received no medication prior to the basal anesthesia; 64 per cent received morphine and atropine; 19 per cent, morphine; 3 per cent, pantopon

* The results of this survey will be published soon.

or codein. One patient was given a combination of scopolamine and morphine. We feel certain, however, that this combination should be particularly avoided as it is too depressing, especially to the respiratory center. The narcotics appear to allay apprehensiveness but, in the dosage given, we obtained no evidence that it deepened sleep or produced greater relaxation. We have also concluded that preliminary medication did not influence the dose of tribromethanol or the amount of supplemental anesthetic required.

DOSAGE OF TRIBROMETHANOL

In surgery tribromethanol should be used to obtain basal anesthesia only and we have confined ourselves to dosages that produce this effect. The amounts varied from 40 mg. per kilo body weight (administered in a few instances) to 100 mg. per kilo, the maximum (Table III).

The average dose of avertin fluid for surgical purposes used was 5.04 c.c. (504 mg. of tribromethanol); the maximum dose given to a male was 8.5 c.c. (850 mg. of tribromethanol); the maximum administered to a female was 8.0 c.c. (800 mg. of tribromethanol).

TABLE III
DOSE OF AVERTIN

Dose Avertin Fluid, c.c.	Mg. of Tribromethanol per Kilo	Per Cent of Patients
0.1	100	40.6
0.08	80	51.8
0.06	60	5.6
0.05 to 0.04	50 to 40	2.0

The dose of tribromethanol required for most young and middle-aged individuals offered no special problem. Children received 80 mg. or 100 mg. per kilo of body weight. These amounts were not exceeded despite the common belief that children are more tolerant to this basal anesthetic agent. Elderly individuals, those past sixty years, were not given more than 80 mg. per kilo.

The calculation of dosage by body weight is not entirely satisfactory (see

also Nordmann,¹⁸ Pribram,¹⁹ Anschuetz,¹ Domanig,⁷ Martin¹⁷). The art of anesthesia can nowhere be better demonstrated than in the induction of basal narcosis. Proper evaluation of the personality of the patient and his general condition, the type and length of operative procedure, etc., all play a part in a satisfactory conduction of the anesthesia which cannot be attained by merely following an inelastic scheme.

TIME OF ONSET OF SLEEP

Drowsiness usually set in soon after completion of the avertin enema (over 73 per cent were asleep after eight minutes). One patient was asleep in one minute, one after twenty minutes. Between these extremes, 22 per cent were asleep in about four minutes and 53 per cent after about five minutes. It was found that the time elapsing from the time of administration to the onset of sleep was dependent on the speed of instillation of the tribromethanol. For the administration five to ten minutes should be taken. Hasty injection induces too rapid an onset of the anesthesia, resulting in undesirable effects on the blood pressure,¹⁵ which are discussed briefly later. A more intensive investigation of the circulation under the influence of different anesthetics is presented elsewhere.¹²

By failure of avertin to have its expected action, we mean that the patient failed to fall asleep after a reasonable time had elapsed following the administration of the enema. In 13 instances it was noted that the patient was only drowsy when the supplemental anesthetic was started. Two of these patients, because of their generally poor condition, received only 50 mg. of avertin per kilogram of body weight. Some of the failures were due to purposely given small doses in the course of study of minimum dosage. Three received no sedative the evening before operation; the rest had a preliminary injection of morphine. Besides the cases in which an error in technique was evident, there were 3.5 per cent of all our cases in which no satisfactory action was observed. There were

no children in this group and there was no case where avertin was given to the same individual more than once. The group of failures includes more women than men and was not confined to any particular pathological condition.

FULL ANESTHESIA WITH TRIBROMETHANOL-AMYLENEHYDRATE

Although in all instances it was sought to produce only basal anesthesia, full surgical anesthesia was obtained in 24.3 per cent of the cases in spite of the relatively low dosages of tribromethanol-amylenehydrate employed. Six per cent of these patients received no sedative in the evening, nor morphine or codein before the operation. This again demonstrates the difficulty in accurately determining the quantity of this drug necessary to produce only basal anesthesia and the need of a more reliable method for calculating a routine dosage. Further study is being made on this problem.

SUPPLEMENTAL ANESTHESIA

Tribromethanol is soluble and stable in amylene hydrate and we have used only this combination. It is to be realized that amylene hydrate has a hypnotic action and that each cubic centimeter of avertin fluid contains 1 gm. of tribromethanol and 0.5 gm. of amylenehydrate. Further investigation is needed to evaluate precisely the effect of the amylenehydrate. According to Grossmann¹³ the combination produces longer sleep than the crystals alone, which, however, is not always desirable.

Approximately one-fourth of the cases in this group received only local anesthesia as a supplement to tribromethanol-amylenehydrate. Sievers,²¹ and others too, observed that frequently local anesthesia at the site and preliminary to the skin incision was sufficient to produce surgical anesthesia for the whole course of the operation.

To those patients of this group who required supplemental anesthesia, nitrous oxide-oxygen (15.8 per cent), ethylene-oxygen (17 per cent), ether (18 per cent),

or a combination of inhalation and local (25 per cent) anesthesia were given. In all instances the necessary dose of the supplemental inhalation anesthetic was only a fraction of the amount usually required for operations performed under exclusive use of the respective anesthetic. In many cases ether or gas had to be administered for only a short time during opening of the peritoneum and again on closing the wound.

In only one case was it necessary to use an amount of ethylene and ether that is usually required for operations without the use of basal anesthesia. This was in a twenty-eight year old woman in whom an appendectomy, dilatation and curettage of the uterus, suspension of the uterus and a trachelorrhaphy were performed. This patient received 80 mg. of avertin fluid per kilogram of body weight, insufficient in view of the age of the patient and extent of the operation.

In one case the supplemental anesthesia consisted, in addition to local anesthesia, of another dose of avertin fluid, with satisfactory result. The operation, a laminectomy with partial resection of a tumor, lasted six hours. The patient had been given 100 mg. per kilo initially and, after four and three-fourth hours, another 80 mg. per kilo.

OBSERVATIONS ON THE CIRCULATORY SYSTEM

In all our cases the blood pressure was recorded every five minutes for some time before the instillation of the tribromethanol-amylenehydrate until consciousness returned. In 12 instances an increase in the systolic pressure was observed; in 24 there was an increase in the pulse pressure during the twenty minutes following completion of the enema containing the drugs. Inasmuch as local anesthesia (novocaine with epinephrin) was used in a relatively large number of the patients, the reason for this increase in blood pressure cannot be definitely stated. In all of the other cases of this series, an average fall of 24 mm. Hg of the systolic pressure was observed, after the onset of sleep. This fall averaged in men

19 mm., in women 28 mm. The drop of the systolic pressure was not always accompanied by a drop of the diastolic pressure.

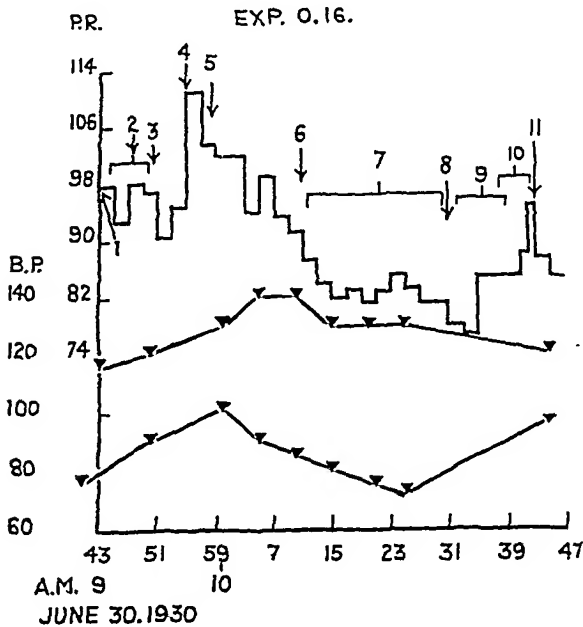


CHART 1. Continuous recording of the pulse rate during hysterectomy, in a woman aged thirty-seven. Administration of morphine gr. $\frac{1}{6}$; atropine $\frac{1}{150}$ (1); avertin fluid 4.8 c.c. (0.1 pro kg.) instillation finished one-half hour ago (2); incision of skin (3); incision carried deeper (4); myoma and body of uterus removed (5); excision of tumor and uterus finished (6); closure of wound (7); completion of suture (8, 9, 10); slight convulsion (11). ▲ = Blood pressure readings.

This is evident since the average drop of the pulse pressure was only 11 mm.; 9 mm. in men and 13 mm. in women.

Except the fall of the blood pressure just mentioned we never observed any other symptoms of shock or circulatory disturbance following the administration of the avertin. The fall in blood pressure noted was similar in every way to that observed in normal physiological sleep (Kennedy,¹⁵ Stuber²³ a.o.). According to Stuber and others the blood pressure in normal sleep may show a fall to 85 to 95 mm. and according to Boas and Goldschmidt⁴ the pulse rate may drop to 52 ± 7.5 in men per minute.

Often the patient is already under the influence of a hypnotic or sedative administered preliminary to the basal anesthetic,

consequently the circulatory depression produced by the sedative or hypnotic, and that by the tribromethanol-amylenehydrate should be differentiated. This is of great practical significance when in an emergency an antidote is to be selected. If, however, preliminary medication is avoided or simplified and the tribromethanol is properly administered (conservative dosage and slow rate of instillation) no such situation will arise.

From the time of the completion of the avertin enema until the supplemental anesthesia or the operation started, the pulse and respiration rates were slightly decreased. With the exceptions already noted the patients seemed in a peaceful sleep before the operation started.

The influence of various anesthetics on the heart beat, including tribromethanol, has thus far been studied in 77 cases. The results obtained by the method of continuous recording of the heart rate with the cardiometer of Boas will be reported later in detail.¹²

Using the cardiometer, Boas and Goldschmidt have studied the heart rate during operations under different inhalation anesthetics.³ The same method has been used in studying the heart rate under the following types of anesthesia:

1. Tribromethanol-amylene hydrate unsupplemented (Chart 1).
2. Tribromethanol-amylene hydratesupplemented by local anesthesia (Chart 2).
3. Tribromethanol-amylene hydrate supplemented by local and ethylene anesthesia (Chart 3).

In these charts we have included the blood pressure readings which were taken every five minutes by the anesthetist.

It should only be mentioned here that the excitement stages at the beginning and the end of the anesthesia are markedly less with the basal anesthesia (Charts 1 to 3). Furthermore it was noted that subsequent to thyroid operations the blood pressure level remained the same although the pulse rate showed the usual drop (Chart 3).

POSTOPERATIVE COURSE

Over one-half of the patients (56 per cent) operated on under tribromethanol-amylene-

In the three non-surgical patients, where a number of tribromethanol-amylenehydrate enemas were given, vomiting did not

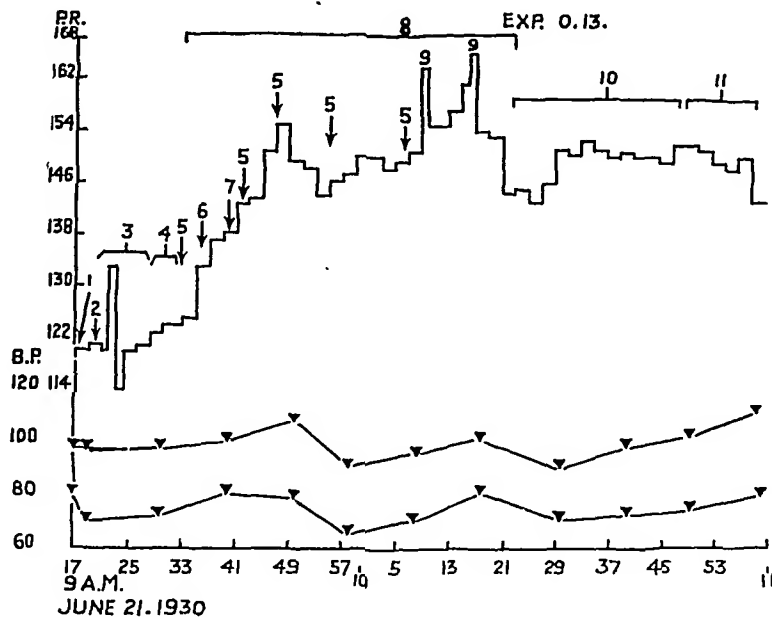


CHART 2. Continuous recording of the pulse rate during thoracoplasty in a woman aged twenty-three. Administration of morphine $\frac{1}{6}$ gr., atropine $\frac{1}{150}$, avertin fluid 3.6 c.c. (0.08 pro kg.) patient sleeping on operating table (1); preparation of operating field (2, 3); resting (4); novocaine injection (5); skin incision (6); administration of morphine sulphate gr. $\frac{1}{6}$ by hypodermic (7); separation of soft parts and ribs (8); removal of periosteum of ribs (9); suturing (10, 11). ▲ = Blood-pressure readings.

hydrate had no pain after the operation, and needed no narcotics. Relatively more women were without post-operative complaints.

Vomiting occurred in only 31 per cent of the cases and as an average seven hours after the end of the operation; thus more delayed than with inhalation anesthesia. Three of these patients vomited regularly also before operation; in five there appeared to be a connection between the vomiting and an injection of morphine, and in one instance it followed the administration of sodium amytal. Vomiting occurred in about three-fourths (77 per cent) of the abdominal and thyroidectomy (76 per cent) cases. Of all the cases that vomited, 22 per cent had nose and throat operations, most of them being adenoid and tonsillectomies and submucous resections. This would indicate the possibility that mechanical factors play a rôle in the causation of vomiting.

occur, with the exception of one case of tetanus. In this instance, serum-sickness developed and vomiting started twenty-four hours after the tribromethanol treatment had been discontinued.

There were a few complaints of intestinal gas and none of intestinal irritation. No postoperative pneumonia or bronchitis was observed. Routine urinalyses showed no abnormal findings. Repeated remarks occur in the histories about difficulties in voiding in the postoperative period. It is impossible to decide whether these complaints were due to the operation per se or the action of the basal anesthetic. The well-known effects of opiates and surgical trauma in producing these difficulties may be kept in mind.

A few patients (11) with hypertension have been given tribromethanol. None of these gave any cause for anxiety or exhibited any particular disturbance of the

cardiovascular system, except that the drop of blood and pulse pressure was relatively more marked. We will discuss suffering with a psychosis and developed a surgical condition for which operation was deemed necessary. He was quite

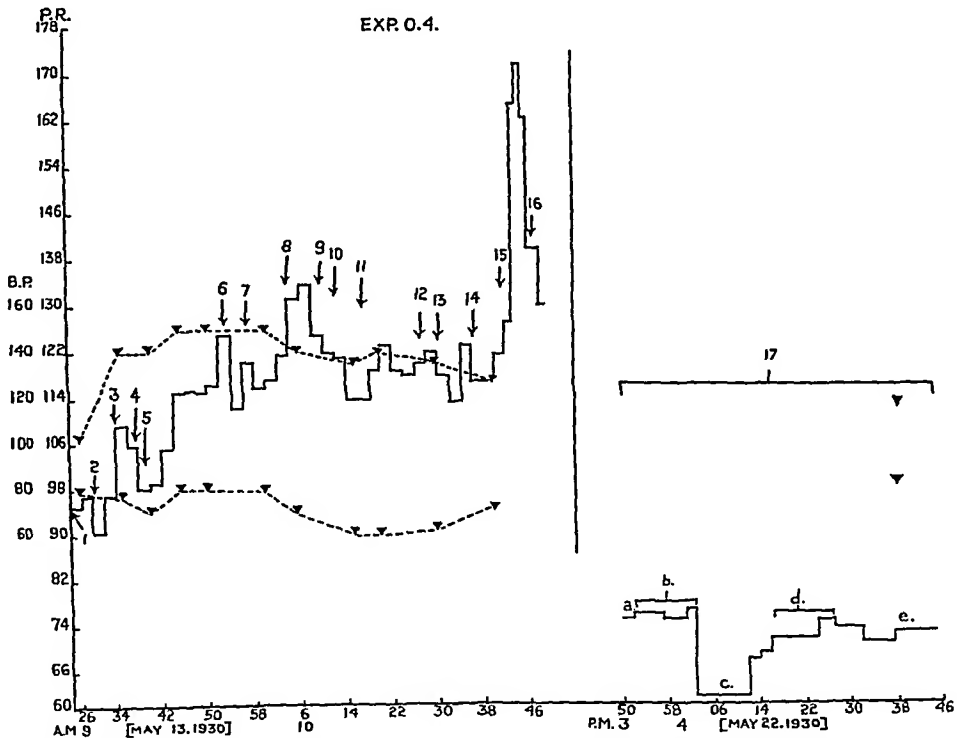


CHART 3. Continuous recording of the pulse rate during subtotal thyroidectomy, left, in a [woman aged thirty-four. Patient asleep following the administration of morphine $\frac{1}{6}$ gr., atropine $\frac{1}{150}$ gr. and avertin fluid, 5.2 c.c. (0.1 pro kg.) (1); preparation of operating field (2); nitrous oxide started (3); novocaine injected (4); skin incision (5); incision carried deeper (6); administration of ethylene (7); ligature placed on left superior thyroid artery (8); removal of left lobe of thyroid gland (9); suture of capsule (10); successive suture of layers of skin (11-14 incl.); administration of ethylene stopped (15); skin suture finished (16). Similar record of same patient nine days later (17); patient lying on back on a stretcher (a); animated conversation (b); reading (c); talking and laughing (d); taking of blood pressure (e). ▲ = Blood pressure readings.

the purposeful production of a fall in the blood pressure and its utilization in ophthalmological surgery (Wessely,¹¹ Wilmer¹²) in a paper dealing with the continuous recording of the heart rate during operations. There were some patients in this group without any drop in blood pressure, and some with a normal drop.

Amnesia was observed in all patients, even in those by whom basal anesthesia was unsatisfactory. There was no recollection of any events after the instillation of the tribromethanol.

The smooth induction period of anesthesia with tribromethanol is particularly striking. Postoperative excitement was observed only once. This patient was

excited for a number of hours after awakening from the anesthesia, spoke of suicide, and had to be calmed by morphine.

The patients slept for variable periods following operation. The average length of sleep was about two hours and ten minutes after the instillation of tribromethanol. In cases of prolonged operative procedure, 90 per cent were conscious at the end of the operation and with the cessation of the supplemental anesthetic. Shortly after regaining consciousness sleep again followed, from which the patient could be aroused. This secondary sleep period averaged approximately four hours and twenty minutes. The hypnotic state, which lasts for a number of hours following

operation, appears to be the reason why no narcotic had to be administered in 36.3 per cent of the cases. By 46.3 per cent of the

of $1\frac{1}{4}$ grs. of luminal the night previous to the operation at 10 P.M. and a hypodermic injection of $\frac{1}{4}$ gr. morphine and $\frac{1}{150}$ gr. atropine

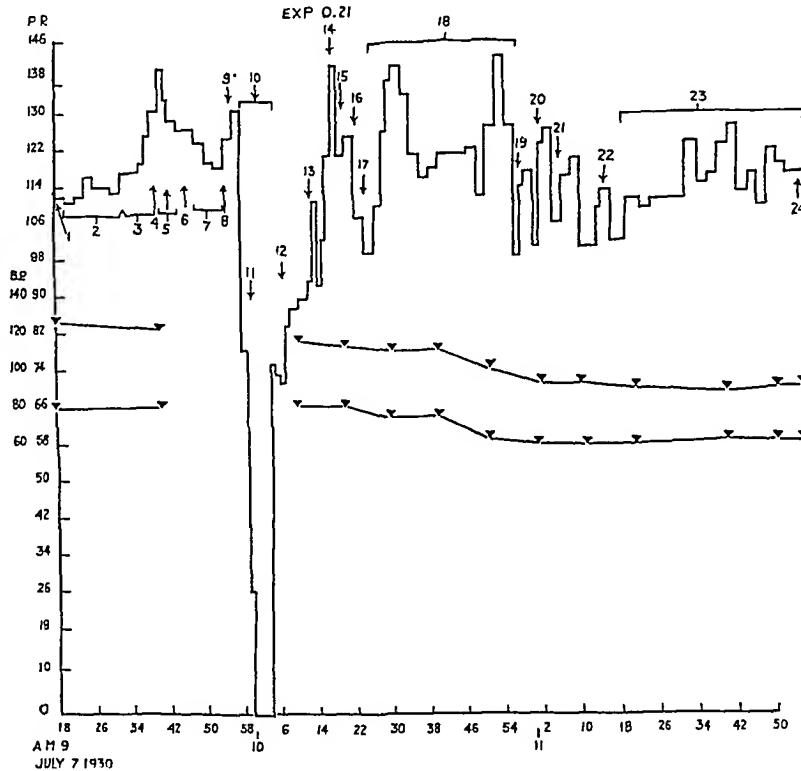


CHART 4. Continuous recording of the pulse rate during supravaginal hysterectomy in a woman aged thirty-eight. Administration of morphine gr. $\frac{1}{4}$, atropine $\frac{1}{150}$, (1); patient talking, slightly excited (2); administration of avertin fluid enema 7 c.c. (0.08 pro kg.) (3); arms secured (4); speaking excitedly (5); relaxed (6); patient placed in position for operation, and preparation of site of incision (7); skin incision, patient talking (8); administration of ethylene, apening of wound, nasal tube introduced, patient cyanotic (9); operation stopped, breathing stopped, shock position, artificial respiration; blood pressure reading discontinued because of artificial respiration (10); administration of adrenalin 1 c.c. in muscles of the arm (11); breathing slowly returns (12); operation continued (13); free oozing followed separation of adhesions (14); administration of ether (15); blunt dissection of uterus (16); ether stopped (17); strong upward traction on uterus to aid in freeing adhesions (18); tying of ligaments (19); patient moans, ether administered for three minutes (20); excision of uterus and tumor (21, 22); closing of wound (23); cardio-tachometer disconnected due to further preparation (24). ▲ = Blood pressure readings.

patients only one injection of morphine was necessary in the first twenty-four hours following operation.

UNTOWARD REACTIONS AND MORTALITY

The only serious complication that arose was observed in the following case of supravaginal hysterectomy:

The patient had a resection of bilateral ovarian cysts in 1917. In 1929 an intraligamentous fibroid of the uterus, the size of about a two and one-half months pregnancy, was removed. This patient was considered a poor risk but operation was nevertheless deemed necessary. Preliminary medication consisted

thirty-five minutes before the avertin enema on the morning of operation. She was given 7 c.c. of avertin fluid, the dose of tribromethanol being 80 mg. per kilo. Supplemental anesthesia consisted of nitrous oxide and oxygen, with the addition of ethylene later. After the ethylene was started, the patient became cyanotic, respiration failed rapidly, and the heart beat was no longer perceptible. Artificial respiration was given, adrenalin was administered intramuscularly, and within four minutes respiration was restored and the cardiac beat could again be obtained. After a short delay the patient was redraped and the operation completed. She recovered after a prolonged stay in the hospital.

By chance the whole accident was registered with the cardiograph (Chart 4). This episode, occurring nearly one hour after the administration of the avertin fluid, probably had no relation to this anesthetic.

MORTALITIES

The death rate is still an unsolved problem in tribromethanol anesthesia. No instances are given in the American literature in which an author reports mortality by intoxication with tribromethanol that has come under his personal observation. In our series there were 4 deaths. We are, however, convinced that in none of these was tribromethanol-amylenehydrate the immediate or remote cause of death. The salient points regarding these cases are as follows:

CASE I. *Clinical notes:* History No. 50766. Mrs. M. K., aged thirty-seven years, housewife. Patient was admitted through the medical service with abdominal pain, nausea and vomiting of five days' duration. Examination showed a very obese, middle aged female, acutely ill. Pulse was rapid, lips cyanotic, respiration rapid, blood pressure 80/60, heart sounds poor quality. Abdomen pendulous, distended; the umbilical folds obliterated and containing a lemon-sized, tender, irreducible mass, the overlying skin dark blue. A diagnosis of strangulated umbilical hernia was made and an exploratory laparotomy performed at once. Morphine sulphate $\frac{1}{6}$ gr. was given and avertin fluid 0.08 gr. per kilo of body weight (5.4 c.c.) per rectum. After the usual preparation an elliptical incision was made and dissection carried out to the neck of the sac, which was opened and excised. A piece of omentum was found in the sac, incarcerated and strangulated on the upper portion of the sac. This was freed and dropped back into the abdominal cavity. In this cavity was found a large amount of dirty brownish fluid which did not have a fecal odor. The abdominal cavity was then opened, disclosing a large multilocular cyst containing the same brownish fluid and located in the gastrocolic omentum, so situated and so adherent that it was impossible to remove it. The omentum and peritoneum showed

small millet seed of what was apparently fat necrosis although the peritoneum was not involved. The patient's condition was not good and she was sutured without further exploration. One large Penrose drain was placed through a stab incision down to the pancreas and the peritoneum sutured. The patient stood the operation very poorly and was unable to leave the operating room on account of shock; sixteen hours after this operation the patient died. Cause of death was cardio-respiratory failure secondary to omental cyst(?).

Necropsy: Permission for necropsy was not obtained.

CASE II. *Clinical notes:* History No. 83700. Mr. F.I., aged fifty-seven years, laborer. The patient was admitted with a diagnosis of intracranial tumor and was transferred to the surgical department where it was decided to do a ventriculocentesis. An attempt was made to do this under novocaine. The patient was quite irrational and could not be handled; consequently he was given avertin fluid 0.1 gr. per kilo of body weight (7.3 c.c.). With this he became readily controllable. An incision was made over the right frontal region and the bone trephined. A ventricular needle was introduced here and the right frontal horn reached at great depth; it contained only a very small amount of cerebrospinal fluid, the flow of which stopped abruptly. A similar procedure was carried out over the left frontal bone and the needle here entered at the customary depth what seemed to be a large horn. Fluid escaped under great pressure and flowed freely for a few minutes; perhaps an ounce of fluid was evacuated and then the fluid began to oscillate from the needle. It was apparent there was no true internal hydrocephalus. On the basis of these punctures it was decided there was a tumor of the right frontal lobe. Later the same day the patient's condition became critical and he was taken to the operating room and a needle again introduced into the left ventricle, with the same result as the previous puncture. After releasing the fluid his blood pressure fell, the pulse went up and he became progressively worse, and died twelve hours after the operation. Cause of death, respiratory failure, due to brain tumor.

Necropsy: Permission for necropsy was not obtained.

CASE III. *Clinical notes:* History No. 85644. Mr. W. S., aged forty-five years, painter. Patient had one previous admission to the hospital one year previous at which time he complained of frequent attacks of vague abdominal distress accompanied by loss of consciousness. Examination at that time revealed no pathology except bilateral inguinal hernias which were repaired. There was a history of appendectomy about ten years previous. Prior to this admission the patient had an onset of mid-abdominal cramps of moderate severity, accompanied by vomiting. He was evidently in acute distress, complaining of abdominal pain around the umbilicus and he vomited at intervals. Vomitus not fecal. Pulse was rapid but regular; abdomen tense, most marked just to the left of the umbilicus. No masses were felt. Impression was acute intestinal obstruction of small bowel type. An exploratory laparotomy was done immediately. Preliminary drug was morphine $\frac{1}{4}$ gr., followed by administration of avertin fluid, 0.08 gr. per kilo of body weight (4.80 c.c.). He had, furthermore, ethylene and novocaine. A left rectus incision was made and a small amount of free fluid was encountered in the peritoneal cavity. Fluid was clear. Large loops of small bowel were seen as well as other loops of collapsed bowel. The incision was lengthened downward for a short distance and here the bowel was found to be tightly adherent to the anterior abdominal wall on the opposite side of the abdomen. This seemed obviously the cause of the obstruction. The dissection was carried out; it was found this was not the sole cause of obstruction as a considerable portion of the small intestine had looped through, resulting in a partial volvulus. The patient was desperately ill and it was felt that the operative procedure should cease as soon as possible. A jejunostomy (Witzel) was used and the abdomen closed. Just as the operation was finished the patient ceased breathing. Artificial respiration was carried out to no avail.

Necropsy was performed four hours after death, with the following anatomical diagnosis: "Old laparotomy scar; peritoneal adhesions involving particularly the small intestine; obstruction (partial) of small intestine; recent operation (exploratory laparotomy, lysis of adhesions, correction of volvulus, jejunostomy); pulmonary congestion and edema. Subsidiary: Pleural adhesions (bilateral)."

CASE IV. *Clinical notes:* History No. 84593, Mrs. C. B., aged sixty-two years, housewife. The patient had a history of goiter and symptoms suggestive of thyroid heart disease over a long period (nine years). Examination shows marked enlargement of left thyroid lobe with strong pulsation of vessels. The patient had lid lag, tremor, and auricular fibrillation. Surgery was probably the only means of permanent relief. Anesthesia: morphine gr. $\frac{1}{6}$, atropine $\frac{1}{150}$, avertin fluid 0.08 gr. per kilo of body weight (4.3 c.c.), ethylene. On incising into the thyroid the capsule of a very large adenoma was exposed and with considerable difficulty enucleated. The patient seemed to stand this procedure fairly well and left the table in fairly good condition. The complete irregularities of the heart from auricular fibrillation which had been present ever since the patient entered the hospital, obscured somewhat the cardiac changes. The patient became more and more restless and dyspneic and four days later, with a clinical diagnosis of cardiac decompensation, death occurred.

Necropsy was performed two hours after death, with the following anatomical diagnosis: "Chronic, acute and suppurative thyroiditis; adenoma of the thyroid; cardiac hypertrophy and dilatation; chronic passive congestion of the liver; generalized edema; hydrothorax (right); pericardial effusion; acute splenic tumor; recent operation, thyroid adenectomy."

REPEATED ADMINISTRATIONS OF AVERTIN

In one patient basal anesthesia was administered four times (carcinoma of the cheek); in 21 patients twice in two-stage procedures such as thoracoplasty, thyroidectomy. The dosage of the second administration was, as a rule, the same as the first. We observed no difference in the action of the tribromethanol when given the first, the second or the third time.

Tribromethanol-amylenehydrate was administered a number of times in two cases of tetanus and one of chorea. In these instances basal anesthesia was all that was required and no supplemental anesthetic was given. Convulsions and spasms characteristic of both conditions were very satisfactorily controlled.*

* For the special indication of tribromethanol in tetanus see Schaefer.²⁰

Table IV gives the essential data regarding these:

tous liver damage and extensive bilateral kidney disease were the only contraindica-

TABLE IV

	Hist. No.	Days under Treatment	Age	Number of Doses	Average Dosage Mg. per Kilo	Total Dose Grams	Result
(1) Tetanus	83837	14	12	21	1.0 (later) 0.06	58.6	Well
(2) Tetanus	A1750	5	12	14	0.06	3 15	Well
(3) Chorea	95056	10	10	28	0.45	36.00	Improved

Of the two cases of tetanus, Case I has been reported in detail by Huntington;¹⁴ Case II presented clinically the same course.

Regarding the case of chorea, the essential data are as follows:

Male, ten years old; diagnosis, chorea; rheumatic heart disease. This patient received 28 avertin fluid instillations each of 35-60 mg. over a period of ten days. Total tribromethanol given 36 gm. There was no evidence of increased tolerance for the drug during this period, the 45 mg. dose almost constantly giving two to two and a half hours of sleep. There were no evidences of any toxic effects or of local rectal irritation. While under the immediate effects of the drug he was very quiet; if, however, a single dose was omitted and the patient was permitted to go for twelve to fourteen hours without an administration, he would become quite restless. On discharge the choreic movements were definitely less violent than upon admission, but the decrease noted during the ten days in the hospital may have been a result of the natural course of the disease. It is, therefore, difficult to evaluate fully the influence of tribromethanol on the underlying disturbance, but it was obvious that the patient obtained a much needed rest while under its influence.

SUMMARY AND CONCLUSIONS

The experiences with 314 basal anesthetics with tribromethanol-amylenehydrate ("avertin fluid") administered to 225 patients are presented. The drug was instilled per rectum as a 2.5 per cent solution in distilled water, usually in doses varying between 0.08 and 0.1 gm. per kilogram of body weight, to patients of both sexes between the age of two and seventy-three years, for operations requiring surgical anesthesia. Parenchyma-

tions for the use of this anesthesia. It is concluded that, administered in sufficient doses, not less than 0.08 gm. per kilogram of body weight, avertin fluid produces a good basal anesthesia. In only about 3.5 per cent of the cases no satisfactory action was observed. In about 24 per cent of the cases full surgical anesthesia was obtained; in about 20 per cent the basal anesthesia was supplemented with local anesthesia (novocaine); in the remaining cases ether, ethylene. oxygen, nitrous oxide, oxygen, or a combination was employed at various phases of the operation. In all instances the necessary dose of the supplemental inhalation anesthetic, however, was only a fraction of the amount usually required for the operation performed.

A temporary fall in the systolic blood pressure of about 19 mm. Hg in men and 28 mm. in women occurred following the instillation. Studies with the cardiometer of Boas showed that the abrupt changes in heart rate produced by excitement at the beginning and the end of the anesthesia were markedly reduced or practically absent. The most striking of the advantages in the use of this basal anesthesia is the complete amnesia observed in all patients, they having no recollection whatsoever of the events following the instillation of the tribromethanol.*

*We wish particularly to thank Dr. Samuel C. Harvey for his interest and cooperation and, furthermore we are indebted to Doctor Grover F. Powers and to Doctor Harry Gordon for the privilege of incorporating their observations in one case of tetanus and in one of chorea. Also, we are indebted to Doctor Arthur H. Morse for the use of his gynecological and obstetrical cases.

URETERO-INTESTINAL ANASTOMOSIS

A SIMPLIFICATION OF THE COFFEY TECHNIQUE*

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NEW YORK

THERE are many patients to whom it would be a great boon if there could be devised a method of diverting the

urinary stream from the bladder whereby they might be kept comfortable, clean and free from danger. Draining the ureters to the outside usually fails in the first two desiderata, though qualifying in the third. Intestinal implantation is, as a rule, comfortable and clean, but there is still attached to the method an element of both immediate, and remote danger.

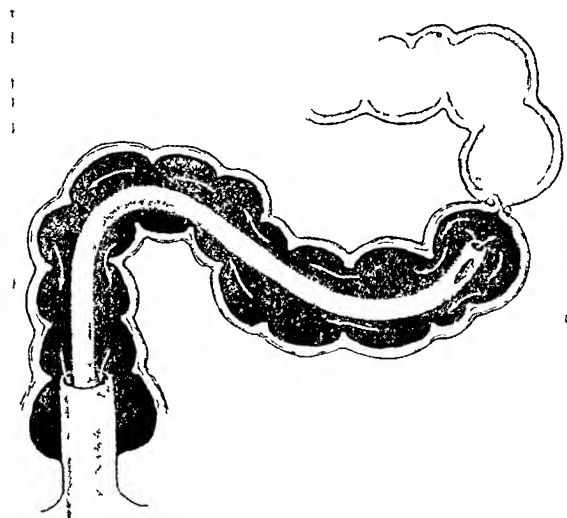


FIG. 1. Large gut, above pelvic brim, is gently clamped with light intestinal forceps, jaws of which are covered with rubber tubing. Through proctoscope inserted above internal sphincter, rectal tube is passed to just below occluding clamp. It is necessary to give this direction manually by the operator, otherwise it will coil up in the rectum. Intestine is cleansed with saline solution followed by 1 liter of 1 per cent mercurochrome. Rectal tube is then withdrawn.

urinary stream from the bladder whereby they might be kept comfortable, clean and free from danger. Draining the ureters to the outside usually fails in the first two desiderata, though qualifying in the third. Intestinal implantation is, as a rule, comfortable and clean, but there is still attached to the method an element of both immediate, and remote danger.

To Coffey belongs the credit of developing a technique that has a low immediate risk, and a fair degree of freedom from late complications. He stresses the importance of forming a valve by having the ureter



FIG. 2. Incision is made through peritoneum along outer side of ureter. At lowest point ureter is doubly clamped and divided. Cephalad end is gently lifted and peritoneum along its inner side and cellular tissue posterior to ureter is carefully dissected free. Retaining peritoneal attachment and surrounding tissue insures better blood supply. Inner incision is prolonged inwards to gut.

termination in the gut lumen. I feel that its virtue is due to the fact that it is between the mucosa and the muscularis. In this position any tendency to ureteral dilatation, as a result of back pressure, can easily take place and stricture does not occur. If the ureter were buried in a canal of the same length formed by sewing the peritoneal and muscular walls of the gut over it, in time there would form a narrow

* Read before the Southern Surgical Society, Lexington, Ky., Dec. 11, 1931.

obstructing channel that would cause hydroureter, hydronephrosis, and pressure atrophy of the kidney substance.

the crutch arrangement can be extended an extra 6 in. beyond the table.

The patient, after the usual skin prepara-

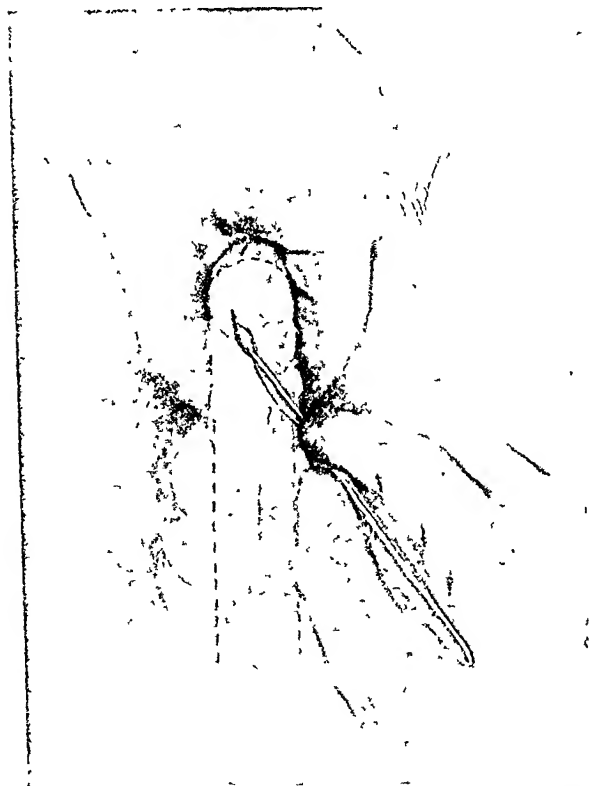


FIG. 3. Proctoscope is passed by an assistant, under manual guidance of operator, to point above that selected for ureter implantation. Gut is made taut over tube, and incised down to mucosa. Incision should be longer than shown.

I have successfully performed what is essentially the Coffey operation three times, and each time a bit differently. The technique I now describe combines the good points of the Coffey and the modifications I finally adopted and used in the third operation.

Spinal is the most satisfactory anesthesia.

The table should be one on which the patient's buttocks may be brought to the lower end, and the legs held apart with the thighs on the same plane as the trunk, and the Trendelenburg position obtainable. I have used the Squier cystoscopic table. This has the disadvantage of being a bit too wide, and the degree of Trendelenburg too limited. A better combination would be one of the modern operating tables with Bierhoff leg holders, so made that

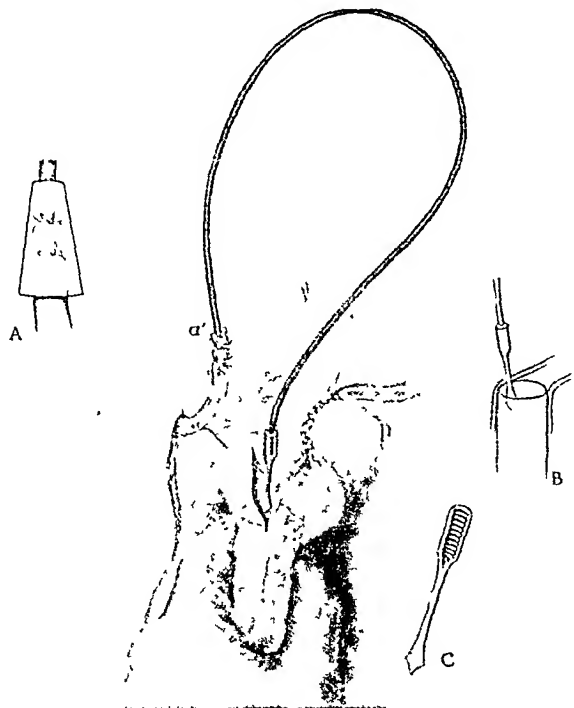


FIG. 4. No. 8 ureteral catheter is tied into ureter. Over catheter is slipped hollow metal truncated cone (see a & A) to facilitate passage of ureter into intestine. On distal end of catheter is screwed spear pointed instrument (c). Lowest end of incision through peritoneal and muscular coats of bowel is made taut over end of proctoscope (b) and trochar plunged through mucosa into bowel. Catheter is long enough to be passed out of anus (through proctoscope). Proctoscope is removed, and by traction on catheter, ureter is pulled into lumen of gut, metal cone making this smooth and easy. Tip (c) is removed from catheter.

tion, is so draped that the abdomen and the rectum are both exposed.

A median low abdominal incision is made, the small intestines displaced from the pelvis. The sigmoid is clamped with a light, rubber-covered intestinal forceps just above the sacral promontory. An assistant introduces a sigmoidoscope into the rectum, which under the direction and manual guidance of the operator, he pushes to a point about 3 in. above the anus. The obturator is withdrawn, and through the sigmoidoscope a colon tube is passed to the clamped gut. The lower intestine is irrigated with saline until the fluid returning

through the sigmoidoscope is clear, then 500 c.c. of mercurochrome 1 per cent are run through.

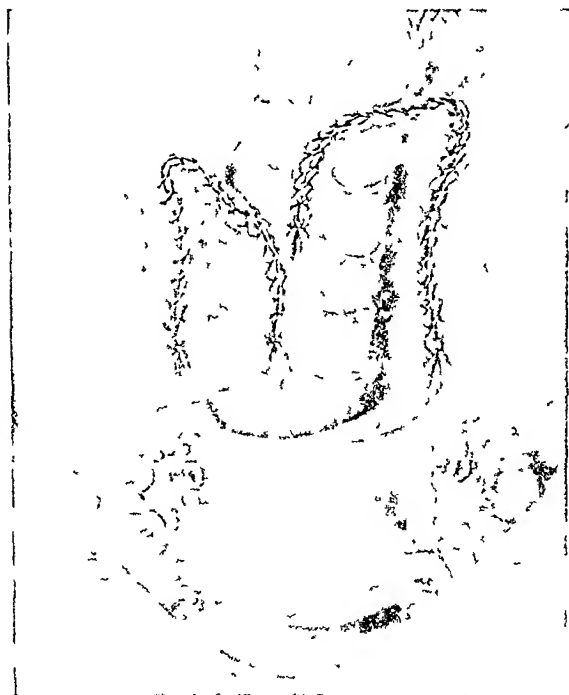


FIG 5 Completed operation.

The sigmoidoscope is removed and a clean one inserted to just short of the point at which the sigmoid is clamped, and the obturator removed.

To dissect the ureter from its bed an incision is made through the peritoneum close to its outer border, and extended downward to the point at which the ureter is divided. The ureter is clamped doubly and divided between the clamps. It is then freed from below upwards, an endeavor being made to retain the peritoneal attachment by dividing the peritoneum along its inner side. This can readily be done on the right; on the left it is not so feasible. But, in any event, the periureteral sheath should be retained, for through it run many of the nutrient vessels of the ureter. About 3 in. of ureter are freed.

The distal segment of the ureter is ligated with No. 1 ten-day chromic catgut to prevent bleeding and possible backflow of urine from the bladder.

A ureteral catheter, No. 8 or 10, with two circular ridges, $\frac{1}{8}$ in. apart, 6 in. from

the tip, is run up the ureter after the clamp is removed, and the ureter tied to it so that the tie falls between these ridges.

A small, truncated hollow metal cone is passed over the catheter and slid up over the tied end of the ureter to facilitate its passage into the gut at a subsequent stage of the operation. A trochar pointed instrument is screwed onto the distal end of the catheter.

The point of implantation is selected. The sigmoidoscope is passed upwards beyond this, and with the left hand the gut is held firmly over it. With a knife an incision $2\frac{1}{2}$ in. long is made to the mucosa. The sigmoidoscope is then manipulated so that the lower end of the incision is drawn taut over its lumen. The trochar is then plunged through the mucosa into the sigmoidoscope, and passed downward through it; the assistant, by pulling on the catheter draws the ureter into the intestinal canal. The muscularis and peritoneum are sutured over the ureter; portions of the periureteral sheath are included in the suturing to prevent displacement. The peritoneal wound from which the ureter was dissected is closed with catgut.

A similar procedure is carried out on the other side.

I do not feel that drainage is necessary unless there has been gross soiling.

In the first case, where only one ureter was implanted at the first operation, I did not use a catheter in the ureter, and only a few drams of urine were collected from the bowel in the first five days. In the second case both ureters were implanted without the use of catheters, and there was practically no urine excreted for five days. A bilateral nephrostomy was planned for 4 P.M., on the fifth day as the patient was becoming uremic. At 3:30 P.M. 5 oz. of urine were excreted so the operation was abandoned. She continued to excrete and in twenty-four hours was passing a normal amount. In the third case both ureters were implanted at the one operation, catheters were left in the ureters for one week, and at no time was there any falling off in the elimination of urine.

TRANSPLANTATION OF URETERS

TO RECTOSIGMOID & CYSTECTOMY FOR EXSTROPHY OF BLADDER

REPORT OF SEVENTY-SIX CASES*

WALTMAN WALTERS, M.D.

ROCHESTER, MINN.

THE results that have been obtained in transplantation of the ureters to the rectosigmoid and the removal of the exstrophied bladder have established this procedure as the preferable method of treatment. It permits urinary control by a competent anal sphincter, it permits removal of the exposed, irritated bladder which is prone to the formation of carcinoma and it prevents dilatation of the ureters and pyelonephritis, sequelae which cause death in most cases in which treatment is not carried out.

The length of life of the majority of patients with untreated exstrophy of the bladder averages from ten to twenty years. Sharply in contrast are the patients on whom ureterosigmoidal transplantation has been performed; 13 such patients operated on at The Mayo Clinic are living and well after a lapse of ten years, and 27 after a lapse of five years. In the last seventeen years at the clinic ureteral transplantation to the rectosigmoid has been done in 76 cases without ureteral catheters, the method described by C. H. Mayo¹⁻⁴ being used. In this series 3 patients died following operation, a mortality of 3.9 per cent. In approximately 81 per cent of the cases excellent results followed operation; in 14 per cent results were fairly good, and in 3 cases they were unsatisfactory.

The return of many of these patients to the clinic on request has made it possible to observe carefully the subjective and objective results obtained. The results of such observation of 35 patients have been reported. Although approximately accurate estimation of renal function can be obtained by study of the chemical con-

stituents of the blood and in some instances information relative to the presence or absence of renal infection can be obtained from ureteral specimens of urine after ureterosigmoidal transplantation, yet the advent and use of solutions intravenously injected has added further valuable information relative to renal function and outline of the renal pelvis and ureters.

The mechanism preventing reflux of liquid feces and gas from the rectosigmoid up the ureters, which would produce pyelonephritis, has been the formation of a valve at the distal 2.5 cm. of the ureter by carrying it between the mucous membrane and the muscularis mucosae of the rectosigmoid, a principle of duct transplantation described by Coffey.⁵ That such a valve functions satisfactorily was assumed if such patients did not have evidence of pyelonephritis. Pyelograms by the intravenous method in these cases have confirmed the assumption that normal renal function without hydronephrosis or hydroureter can be expected in cases in which there are no clinical signs or symptoms of urinary obstruction or pyelonephritis.

A patient who is now aged forty years occasionally returns to the clinic for observation. The ureters were transplanted into rectosigmoid and the exstrophied bladder was removed by C. H. Mayo in 1916. This patient affords a striking example of favorable results in such cases (Fig. 1 b). He has not been ill since the operation. There has never been any evidence of renal infection. Tests of renal function by means of solutions injected intravenously have shown the renal pelves, calices and ureters to be normal in size

* Read before the German Surgical Congress, Berlin, April 8-10, 1931.

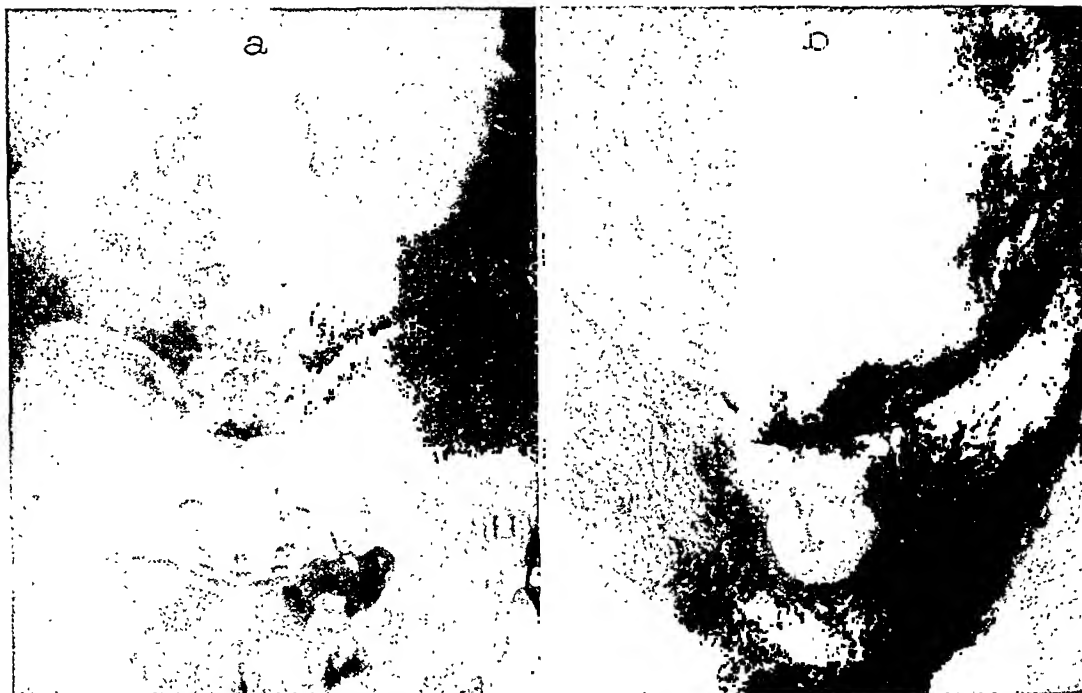


FIG. 1. *a*. Intravenous pyelograms fourteen years after ureterosigmoidal transplantation. *b*. External genitalia fourteen years after ureterosigmoidal transplantation and cystectomy for exstrophy of bladder.

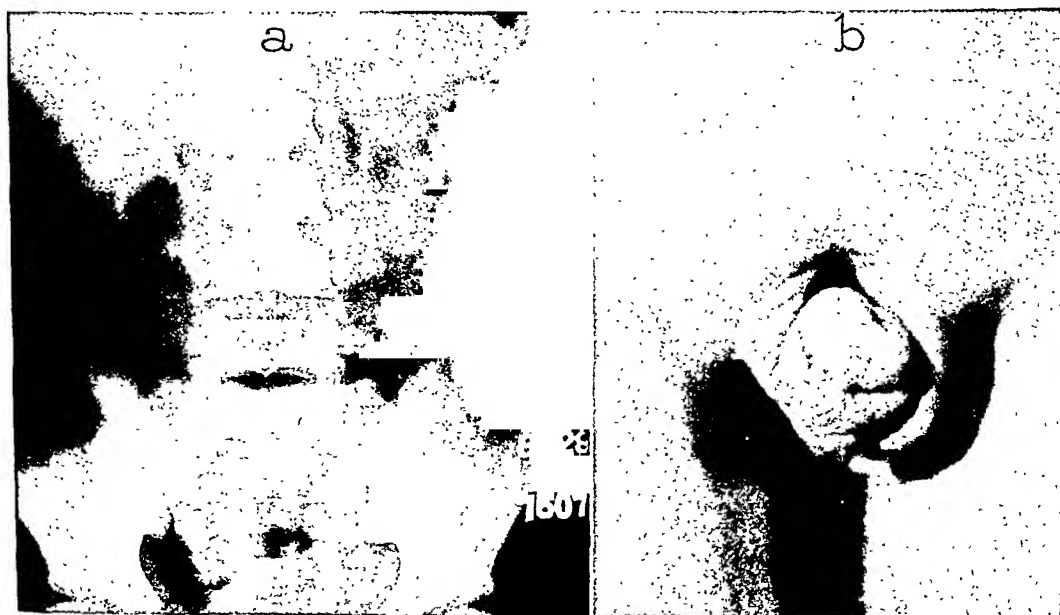


FIG. 2. *a*. Postoperative intravenous pyelogram with normal pelvis, calices and ureters. *b*. Complete epispadias with absent urinary sphincters.

(Fig. 1 a), and with a normal concentration of dye in these areas. The blood nitrogen also showed normal values. The retention of urine in the rectum by a competent rectal sphincter enables him to hold urine for from four to five hours during the day and from six to eight hours during the night. December 16, 1930, I performed a plastic operation on the patient's penis, transplanting a flap of skin from the anterior abdominal wall to the upper portion of the penis to serve as a channel for the transmission of seminal fluid to the end of the penis. Other than this, the external genitalia are normal.

Somewhat similar progress has been made by two women on whom ureterosigmoidal transplantation for exstrophy of the bladder was done by C. H. Mayo in 1913 and 1917, respectively. These women married. The one operated on in 1913 was delivered of normal twins in 1924 and the other was also delivered of a normal child in 1924. Excellent operative results have persisted. The former of these two patients had the ureterosigmoidal transplantation at the age of thirty years.

The purpose of this paper is to summarize the results of ureterosigmoidal transplantations in a group of 76 cases in which the ureters have been transplanted one at a time without the use of ureteral catheters (C. H. Mayo method). An intervening period of ten to fourteen days is allowed to elapse between operations. The submucous transplantation of the end of the ureter as described in 1911 by Coffey⁵ in his experimental work of transplantation of the common bile duct and applied by C. H. Mayo to ureterosigmoidal transplantation in February, 1912, has been used in all of these cases. It might be said here that such a method of transplantation, when properly done, is safe, is followed with excellent functional results, and in only a few instances is there evidence of pyelonephritis.

URINARY CONTROL

If ureterosigmoidal transplantation is carried out in the presence of a satisfac-

torily functioning rectal sphincter the patient will be able to retain the urine in the rectum on an average of from two to



Fig. 3 Intravenous pyelogram seven years after ureterosigmoidal transplantation

four hours during the day and from three to five hours during the night; such a condition existed in the 59 cases in which the patients have been traced and are known to be living.

Experience has shown that it is unwise to carry out ureteral transplantation on children until the child is old enough (usually after the age of three years) to have gained good rectal control of fecal material. In the group of cases reported, urinary control by rectal sphincter was uncertain in 9. In only 2 of the cases was the rectal control disappointing, and in these there was evidence prior to operation that the rectal sphincter was not competent. Fecal incontinence was reported and absence of a gripping anal sphincter was noted on examination of the rectum. In the other 7 cases there was partial control

EFFECT ON KIDNEYS

In 30 (50 per cent) of the 59 cases there has not been evidence of renal infection. In 13 cases (21 per cent), slight evidence of mild renal infection has occurred at long intervals. Usually the infection is manifested by the presence of fever lasting for a day or two with or without lumbar pain. However, there may be weeks or months of normal and comfortable existence between episodes. The infection is mild and has little noticeable effect on the patients; if patients are children, they continue apparently to develop satisfactorily, and become immune to the infection. Further evidence of mildness of the infection is the fact that of 9 patients who died at home in periods varying from one to seven years subsequent to operation, only 1 patient presented definite evidence of renal infection as the cause of death.

The use of compounds such as uroselectan and skiodan intravenously injected makes it possible to study renal function as well as the outline of the renal pelvis and ureter in many of these cases. The normal pelvis, calices and ureters with normal concentration of the dye in the case in which operation was performed in 1916, have been mentioned (Fig. 1 a). The postoperative pyelogram (intravenous) of a boy aged ten years with complete epispadias and absence of urinary sphincters shows normal renal pelvis, calices and ureters (Fig. 2).

A boy, aged thirteen years, whose ureters were transplanted to the rectosigmoid in 1922, returned for a plastic operation on the penis September 18, 1930. He is one of the first patients on whom the intravenous urographic medium was used. Although the outline of the renal pelvis and calices is indefinite, the outline of the right renal pelvis, calices and ureter shows these structures to be normal in size (Fig. 3). The boy's health has been excellent since the operation. There has been no evidence of renal infection and the blood nitrogen values are normal.

A man, aged twenty-four years, was operated on July 29, 1930. As not infrequently occurs in adults if the exstrophy has been permitted to continue without intervention, the lower half of both ureters was considerably dilated (Fig. 4 a). An attempt was made, without much benefit, by introducing catheters into the ureters prior to operation, to decrease this dilatation. An extraperitoneal approach to the ureter was therefore deemed advisable in case unsatisfactory healing of the anastomosis might occur. The right ureter was exposed retroperitoneally; then through a small opening in the adjacent peritoneum, the sigmoid was brought out extraperitoneally and the transplantation was carried out in the usual manner. The peritoneum was then stitched to the sigmoid, and the anastomosis was made retroperitoneally. This extraperitoneal method was chosen because it has been suspected that the larger the end of the transplanted ureter, the greater the possibility of leakage, and such was the case in this right extraperitoneal ureterosigmoidal transplantation, for both urine and feces in small amounts drained from the incision for approximately a week. Healing then occurred spontaneously by secondary intention. With the healing of the right ureterosigmoidal anastomosis, similar extraperitoneal transplantation of the left ureter to the sigmoid was carried out. This anastomosis healed without any evidences of leakage. The postoperative convalescence was without incidence. Intravenous urography showed the dilated ureters to have decreased appreciably in size (Fig. 4 b). At the time of the patient's dismissal, October 27, 1930, he was able to retain the urine in the rectum for from four to six hours during the day and for a similar period during the night. October 3, 1930, a plastic operation was done on the penis (Fig. 5 a and b).

LENGTH OF POSTOPERATIVE LIFE

The tabulation shows the length of postoperative life of the 59 patients who were

traced and the ages of the patients at operation. More than five years have elapsed since operation on 27 patients, and

to the transplantation of the remaining ureter.

The first case was that of a woman aged



FIG. 4 *a* Preoperative pyelogram. Marked dilatation shown of lower half of ureters *b* Postoperative intravenous urogram.

ten years have elapsed since operation on 13. Twenty patients who were operated on were aged from five to nine years; 40 were operated on before the age of fourteen years and 17 were operated on between the ages of fifteen and thirty-four years.

MALIGNANCY ASSOCIATED WITH EXSTROPHY OF BLADDER

Not included in the series of 76 cases of bilateral transplantation, were 2 cases of malignancy of the exstrophied bladder in which solitary kidney was associated. In both of these cases the opposite kidney had been previously removed for pyelonephritis, in 1 case a month before the transplantation of the ureter from the remaining kidney, and in the other, five months prior

thirty-nine years. A diagnosis had been made of adenocarcinoma, graded 2, in the exstrophied bladder, following the removal of the right kidney. January 29, 1926, a month after the infected kidney had been removed, the left ureter was transplanted into the sigmoid by the Coffey method of introducing a ureteral catheter up the ureter and pulling its lower end out through the anus for drainage. Cautery excision of the malignant bladder was done February 8, 1926. The subsequent course has been one of intermittent obstruction of the ureter, possibly at the site of the transplantation. This has necessitated external renal drainage of urine on four occasions, the last one, October 12, 1928, being permanent nephrostomy. The patient re-

turned to the clinic September 27, 1930, with the nephrostomy tube in place and apparently in a satisfactory condition,

passing urine well and was able to hold it on an average of two hours. Her general health and appetite were good. Data



FIG. 5. a. Exstrophied bladder and penis before operation.
b. After cystectomy and plastic operation on penis.

although she was having some pain in the right flank.

The second case, that of a man, aged twenty-one years, had left nephrectomy performed for pyonephrosis with stones April 26, 1918. Five months later, September 19, 1918, the right ureter was transplanted into the rectosigmoid after the C. H. Mayo method. Slight prolapse of the rectum was noted at this time. Since operation, the patient's general health has been good and his appetite has been good. He urinates about six times during the day. He has been troubled with incontinence at night, but it is becoming less.

In 2 other cases the exstrophied bladder was carcinomatous. One of the cases was that of a child aged six years. The right ureter was transplanted June 18, 1921, and the left was transplanted July 6, by the C. H. Mayo method. The bladder was excised July 20, and microscopic examination disclosed squamous-cell epithelioma. The patient returned to the clinic in June, 1922, complaining of some irritation at site of the bladder. A fragment of the bladder was removed at this time and was reported to be squamous-cell epithelioma. She was

concerning this case have not been obtained since 1927.

The other case was that of a woman aged twenty-three years. April 18, 1917, the right ureter was transplanted into the sigmoid and May 17, the left ureter was transplanted, by the C. H. Mayo method. May 22, 1919, the bladder was excised and also the stumps of the ureters. The patient returned to the clinic September 10, 1919, at which time fragments of the mucosa of the bladder were examined microscopically, and a diagnosis of a papillary epithelioma was made. Between September 16, 1919, and February 27, 1920, she received a series of radium treatments. She died May 5, 1920.

OPERATIVE TECHNIQUE OF URETEROSIGMOIDAL TRANSPLANTATION

In the group of 76 cases reported in this paper, the method of transplantation described by C. H. Mayo has been used. A detailed description of this technique has been published but a brief abstract will be given here in order to call attention to its variation from a method now used by Coffey.⁶

The right ureter is transplanted into the rectosigmoid in the first operation, its distal end being carried approximately 2.5 cm. in a trough made by a longitudinal incision along one of the longitudinal bands of the rectosigmoid through the serosa and the muscle layers of the bowel, and carried down to, but not through, the mucous membrane. Lateral separation of these structures furnishes a trough. A small puncture is made in the mucous membrane at the lower end of the incision to allow the passage of the ureter. A curved needle carrying number 0 catgut is then passed through the open end of the ureter and tied to it. The short end of the catgut is guided into the open end of the ureter for a distance of 5 to 6 cm. to insure that the ureter remains patulous during the early days of edema following its transplantation. A curved needle is passed through the opening in the mucous membrane to emerge 1.5 cm. below the incision, drawing the ureter into the lumen of the bowel where the catgut is tied. The divided peritoneum and muscles of the intestine are sutured over the ureter with two rows of catgut. Two or three additional sutures should be used to fix the bowel to the peritoneum to cover and to avoid kinking the ureter and to avoid traction on it. By this method, the ureter is incorporated in the bowel for a distance of about 2.5 to 3 cm. Pressure in the sigmoid from gas or fecal material closes the ureter but does not prevent normal intermittent emptying of the ureter by peristalsis. Ten to fourteen days later the left ureter is transplanted into the rectosigmoid. This permits sufficient time for the previously transplanted ureter to function and allows any mild symptoms of pyelonephritis which may occur to subside.

Prior to the use of this method of treating exstrophy of the bladder, other methods were used such as plastic operations for closure of the bladder, which was performed in 8 cases, the Moynihan⁷ operation in which the vesical trigone containing the ureteral orifices was sutured into an incision

made in the wall of the rectosigmoid in 2 cases, and recently, the Coffey method with the use of ureteral catheters and transplantation of both ureters carried out simultaneously in 2 cases. Experience has shown the impracticability of attempting closure of the exstrophied bladder which has no sphincter and hence no urinary control. It has been noted in the clinic that the catheter method of Coffey, transplanting both ureters simultaneously, has carried considerable increase in risk in very young children. This may be due to the ill effects of prolonged operation or to bilateral renal infection occurring simultaneously which may prevent recovery before the patient becomes immune to infection.

In the series of 76 cases in which the C. H. Mayo method of ureterosigmoidal transplantation was carried out, and the exstrophied bladder removed, the condition of 59 of the patients has been described in detail. Three patients in the group of 76 died in the hospital. Nine patients, after successfully recovering from operation, returned home to succumb months or years later from intercurrent disease. The cause of death of 8 of these had no relation to the ureterosigmoidal transplantation. One patient had evidence of renal infection. Five of the patients who recovered and returned home in good condition were not traced subsequently.

SUMMARY

The results obtained in transplantation of ureters to the rectosigmoid and removal of the exstrophied bladder in a group of 76 patients operated on at The Mayo Clinic are reported. The method of transplantations was first used by C. H. Mayo in February, 1912; he applied Coffey's principle of submucous duct transplantation to the ureter. The operative procedures have been divided into three stages: (1) transplantation of the right ureter into the rectosigmoid, (2) two weeks later transplantation of the left ureter, and (3) ten days later removal of the exstrophied bladder. In none of those cases were

RADICAL ELECTROSURGICAL MASTECTOMY

REPORT OF ILLUSTRATIVE CASE*

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THIS report is typical of radical electrosurgical mastectomies using the Halsted technique. A discussion follows emphasizing points of interest:

Abstract of History: Mrs. B. M. S., an American housewife of sixty-one years, entered the hospital March 14, 1930, complaining of a lump in left breast.

Family History: Mother had pelvic cancer, probably uterine; fatal at sixty-six. Father died at ninety-two years of old age.

Past History: Essentially negative, except for x-ray treatment of a tumor of the left breast, 1907. No biopsy.

Present Illness: Duration of lump six months. Ever since the x-ray treatment, twenty-two years ago, there has been discomfort over the upper part of the breast from atrophy, with lack of pigment and telangiectasis with scaling. Six months ago she removed a crust allowing granulations to pop out which have grown into a papillary mass exuding serum and pus.

Physical Examination: Weight, 132 lb. Nutrition excellent. Temperature, 99°F. Pulse, 85. Respiration, 16. Blood pressure: systolic 118; diastolic 75. Blood count normal.

Left breast is the seat of an extensive involvement as shown in Figure 1. There is a soft, dark-red growth $\frac{3}{4}$ in. at the base, $\frac{3}{4}$ in. above the nipple and raised from the skin about $\frac{3}{4}$ in.; serum and pus exuding. The skin over the upper half of the breast shows marked involvement.

X-ray Report: "The growth appears to be entirely outside of the chest wall."

The Malignancy Committee of the Hollywood Hospital reviewed this case and recommended radical amputation with axillary dissection.

Operation (March 19, 1930): Anesthesia: chloroform, $1\frac{1}{2}$ dr.

A radical breast operation was performed after the method of Halsted and using electrosurgery, removing the pectoralis major and minor muscles, together with the axillary contents. No ligatures were necessary, silk-

worm gut retention sutures bringing the skin edges together which were further approximated with a running suture. One cigarette drain was placed in the axilla.

Pathological Report: Microscopic section shows a tumor growth apparently originating in the form of plug, producing large gland-like punctures. There is a marked round cell and leucocytic infiltration. The derma is dense and fibrous. A quarter of the growth seems to be definitely demarcated to the limits noted in the gross specimen. Cells are small and not highly differentiated; nuclei large; mitotic figures occasionally seen. Diagnosis: epithelioma (V. L. Andrews).

Postoperative Progress: The convalescence of the patient was uneventful except for a rise of temperature on the first postoperative day to 101°F., less on a few subsequent occasions. The wound was painless; drained freely, but did not become infected. The patient sat up in bed on the third day and walked to the bathroom on the fifth day. On the seventh day she was able to lift the arm above the head without assistance, and all stitches were removed on the ninth day, but the wound gaped a little because of the large amount of skin removed at operation; the skin flaps, however, were adherent to the chest and where coapted to each other. Patient was discharged on the ninth day with normal use of arm (see Figs. 2 and 3).

Dr. R. Nichol Smith, a member of the Malignancy Committee of the Hollywood Hospital, who witnessed the operation and watched the convalescence made this comment:

"I was present at the operation on March 19 and have dressed Mrs. B. M. S.'s breast three times since. I am much interested and satisfied with the rapid progress the patient made after having been operated on with electrosurgery. I had expected to see much more sloughing and, in fact, expected the whole ultimately healed by granulation, whereas, now we have a wound that should heal very rapidly with what little granulation

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is necessary. Skin flaps adhered to the chest wall by first intention, which I believe is something new in this process. Studying this

apparatus lies in the ability to give the patient no more than a 2 per cent mixture of chloroform and air at any one time,



FIG. 1. Massive breast tumor on admission.

FIG. 2. Two weeks after admission, skin flaps healed to chest wall with slight gaping because of skin lost at operation.

FIG. 3. Excellent use of arm two weeks after operation.

case from the standpoint of the amount of sloughing, I would say the results are more than gratifying."

Comment: This case, like others of its kind, draws attention to many pertinent facts illustrating the efficiency of the electrosurgical operation:

1. Anesthesia. I am indebted to Dr. Cecil Reynolds for the use of a Harcourt chloroform apparatus (Fig. 4). The chloroform inhaler consists of a cone connected by tubing to a valve, which, in turn, communicates with respiratory valves, to one of which a specially designed chloroform bottle is attached, left in the illustration. The indicator from the valve shows the saturation of anesthetic used; therefore, when the pointer is to the extreme right the patient is getting pure air, in the center, 1 per cent chloroform and at the extreme left, 2 per cent chloroform. By starting with pure air and taking about five minutes to shift the pointer to the left or bottle side, the patient is gradually anesthetized and can be carried along nicely on 1 or 2 per cent mixture. A glance at the valve indicates the condition of the patient's respiration. The safety of this

this being a safe limit to be carried on smoothly. This constant flow of chloroform-vapor accounts for the small amount of anesthetic required and the elimination of the surplus of drug lessens the chance of damage to the liver. Chloroform anesthesia is logical for use in electrosurgical operations as it is non-explosive.

2. Operation. The usual Halsted incision was made and the skin flap dissected back to the limits of the breast tissue without bleeding. A finger inserted under the pectoralis major and minor muscles was replaced by a sterile wooden spatula (Fig. 5), protecting the underlying structures as the muscles were slowly severed by the current down to the spatula. Beginning in the axilla the vessels and nerves were skeletonized and the muscles and breast tissue, together with the axillary fat and glands, were taken away. No ligatures were used, as the current caused sufficient coagulation to make the dissection bloodless. A stab wound allowed a cigarette drain to be placed in the axilla, the skin flaps being coapted by three mattress sutures and a running suture of silk worm gut. Dressings were applied.

Figures 2 and 3 illustrate the adherence of the skin flaps to the chest wall and the excellent use of the arm.

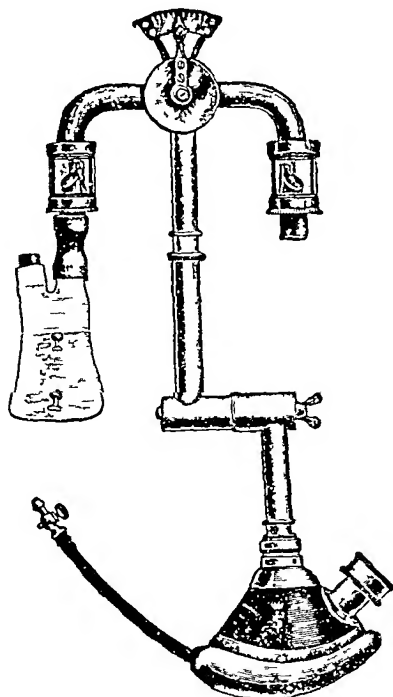


FIG. 4. Chloroform apparatus.

An electrosurgical wound free from blood without the use of hemostats or ligatures, and covered by a sealed surface goes a long way in the prevention of the spread of the disease or local recurrence, proving its own worth. As a rule, healing after the use of a strong electrosurgical current is by slight scabbing and substitution of the scabs by scar tissue. Usually wounds are firm in three weeks, sometimes within two weeks. There is considerable outflow of serum from the heat of the current, but no secondary hemorrhage or infection. The arm is kept to the side of the chest for three or four days, when the patient is allowed out of bed and encouraged to use the arm to prevent scarring in the axilla.

To recapitulate: the salient facts in the care of this typical case are:

1. A radical Halsted operation was done



FIG. 5. Severance of pectoral muscles on wooden tongue depressor, preventing accidental injury to underlying structures.

in one hour and a quarter, with loss of less than a dram of blood.

2. One and one-half drams of chloroform were all that were necessary to keep the patient asleep for one and one-half hours. (She was awake before leaving the operating room.)

3. The wound was healed within three weeks, except for an area which could not be covered by the skin flap on account of the large amount of skin lost at the operation.

4. There was no postoperative pain or undue discomfort and no shock from the anesthesia or operation.

LUMBOSACRAL SYMPATHETIC GANGLIONECTOMY

ITS VALUE AS A THERAPEUTIC MEASURE FOR THROMBOANGIITIS OBLITERANS
(WITH A SIDELIGHT UPON ALLEGED SYMPATHETIC INNERVATION OF THE TONUS
OF THE SKELETAL MUSCLES)*

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LERICHE'S epoch-making achievement in the therapy of perforating ulcers of the foot and certain other trophic disturbances of the extremities resulting from injury to the peripheral nerves by the so-called periarterial sympathectomy has aroused an interest among the clinicians so widespread that the literature accumulated today on the surgery of the sympathetic nervous system has become enormous.

As early as 1872 Nussbaum performed peripheral nerve stretching in treating trophic ulcers of the lower extremities. Reasons for beneficial effects of the procedure were totally unknown until quite recently when they came to be attributed to the degeneration of the sympathetic fibers contained in the nerve trunk. Since then Chipault, Blanc y Fontacin, Volkmann and others have obtained excellent results from the same operation. Other methods of treatment were soon devised, in which the nerve trunk was either frozen with carbon dioxide snow (Läwen) or injected with alcohol (Sicard, Silbert, Rasumowski) and excellent results were obtained in the hands of the originators.

It was in 1889 when Jaboulay first introduced the type of operation now known as periarterial sympathectomy, but uncertainty of the results from the few cases in which it was applied prevented its further trial. To Leriche's insistence upon the value of the operation, therefore, most of the credit for the present-day popularity of the surgery on the sympathetic system is due.

In 1923, one of us (Ito) conceived the idea that the removal of the lower lumbar

and possibly also upper sacral ganglia and cord might be preferable to Leriche's operation in that all the sympathetic fibers would then be excluded at their origin. This idea was immediately put to a practical test by a series of animal experiments, and while these were going on the preparation for the clinical application was being made. The results of the experiments, to be described briefly below, in general confirmed our idea and were published in 1924, but the first clinical application was not made until Jan. 21, 1925, when a patient having gangrene of thromboangiitis obliterans of four years' standing was operated upon by one of our pupils (Osawa) and the result obtained was miraculous.

The section of the rami communicantes of the lumbar region was performed by Royle and the report published in 1924. Since then this method of operation was apparently tried by several others, including Leriche himself, Kanavel and Davis and von Lackum to mention a few. Recently a report of Adson and Brown upon the treatment of Raynaud's disease by a method of operation almost identical with ours interested us considerably. In it they refer to their previous report on the same subject which was published in 1925, the first operation having been performed by Adson in July, 1924, a fact which entirely escaped our attention. According to these authors it is evident that Diez had recommended similar operation for Raynaud's and other trophic disturbances of the lower extremities. It is quite apparent then that the same idea was developed and a practically identical

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method established simultaneously in different lands, unknown to the authors.

It is of interest furthermore that Adson who first removed the lumbar sympathetic ganglia was at first concerned in the relief of muscular spasticity, later applying the technique of operation to Raynaud's disease, whereas we were mainly interested in the trophic disturbances of thromboangiitis obliterans, since the latter disease is far commoner in Japan than Raynaud's, comparatively few cases of which having been treated by us.

BRIEF SUMMARY OF OUR EXPERIMENTAL OBSERVATIONS

Our first object was to determine the effect of Leriche's operation upon the volume flow of blood per minute through the corresponding limb. Kobayashi in our laboratory has found in the dog that from thirty minutes to four hours after the operation there is a decline in the volume flow through the parts supplied by the artery operated upon, and that from four and one half hours on there follows a definite increase of the same and the upward tendency continues up to four days when the maximum flow is observed; but that after the eighth day there is a gradual decline. Forty-one days after the operation there is no difference in the volume flow of blood between the operated and unoperated sides. This point is well brought out in Tables I, II and III.

TABLE I
DOG. NO. 1. 8 KG. MAY 23, 1923
Volume flow of blood in c.c. per minute. Blood taken from the femoral vein. Left-sided Leriche's operation

Length of Time after Operation		Blood Flow per Minute	
Hours, O'clock	Minutes	R	L
0	30	4.295	4.145
1	30	5.142	4.384
2	00	5.440	4.235
2	20	6.240	5.478
4	00	5.266	4.333

TABLE II
DOG NO. 11. 17.5 KG. 4 DAYS AFTER LEFT-SIDED OPERATION

Time Test Made		Blood Volume in C.C.	
Hours, O'clock	Minutes	R	L
12	30	12.206	14.282
2	00	10.865	13.144
2	30	9.511	12.512

TABLE III
DOG NO. 13. 6.45 KG. 41 DAYS AFTER LEFT-SIDED OPERATION

Time Tests Made		Blood Volume in C.C.	
Hours, O'clock	Minutes	R	L
11	10	11.545	12.308
12	00	11.614	12.000
1	00	11.052	11.052
2	00	7.903	8.672

The experiment shows clearly that although Leriche's operation definitely enhances the volume flow of blood through the tissues supplied by the artery whose perivascular tissue has been removed, yet its effect is at best temporary. The determination of the influence of the operation upon the skin temperature in clinical cases likewise shows a temporary nature of the effect. Such a result is to be expected from the anatomical fact that the vasoconstrictor fibers are distributed segmentally and mainly course through the mixed nerve.

Concerning the nature of the vasodilatation which follows Leriche's operation, it has been assumed generally that the removal of the vasoconstrictors was the sole reason. But Osawa, in our laboratory, has found that when the posterior roots of the both limbs has been divided in the dog the subsequent Leriche's operation fails to bring about vasodilatation, and that the existing vasodilatation following the periarterial sympathetic neurectomy disappears upon severance of the posterior roots of the corresponding limb. Upon

these experimental results it has been concluded that the vasodilatation observed after Leriche's operation is reflex in nature, depending upon the centripetal stimulus passing through the posterior roots and upon the centrifugal vasodilator impulse which reaches the blood vessel by way of the parasympathetic fibers of the posterior roots.

Our next object was to study the effect of lumbar sympathetic ganglionectomy. Kobayashi extirpated in the dog the sympathetic ganglia of the fourth, fifth, and sixth lumbar vertebrae and the intervening cord on one side. Following this operation the peripheral arteries were found to retain contractility in response to adrenalin but to have lost the similar reaction in response to cold application. The latter function has remained defunct even one hundred days after the operation.

The volume flow of blood was increased immediately after the operation and remained increased for one hundred ninety-two days which was the longest period of our observation. It is noteworthy that the extent of the increase has been uniformly much greater in the ganglionectomy series than in the periarterial operation (see Table IV, etc.).

Leriche has shown that a wound in the ear lobe of the rabbit heals much more rapidly on the side on which the cervical sympathetic ganglia were removed. Lehman opposed Leriche's conclusion on the ground that the periarterial sympathetic neurectomy in the dog does not hasten the healing of the wound on the corresponding limb. The same writer also maintained that the vasodilatation following the sympathetic chain has little to do with wound-healing, basing his opinion upon his experiments on dogs and rabbits. Fujita, on the other hand, repeated Leriche's experiments and fully confirmed his conclusions. Kobayashi in our laboratory injected an equal amount of suspension of *Staphylococcus aureus* into the subcutaneous tissue of both ear-lobes of the rabbits and showed that the rate of disintegration of the

TABLE IV
DOG NO. 1 F. 9.78 KG. LEFT-SIDED 4TH AND 5TH LUMBAR
SYMPATHETIC GANGLIONECTOMY

Length of Time after Operation in Minutes	Blood Flow Per Minute in C.C.	
Minutes	R	L
1	7.058	24.000
8	8.000	15.384
13	8.275	14.142
18	8.108	15.000
28	8.000	14.457
33	8.000	13.953
38	7.185	13.043

TABLE V
DOG NO. 4 A. 6.2 KG. 4 DAYS AFTER LEFT-SIDED
GANGLIONECTOMY (LUMBAR 4, 5, 6)

Time Tests Made		Blood Flow Per Minute in C.C.	
Hours, O'clock	Minutes	R	L
11	30	6.000	16.627
12	00	4.848	11.951
12	30	4.971	12.000

TABLE VI
DOG NO. 18. 10.5 KG. 192 DAYS AFTER LEFT-SIDED OPERA-
TION AS IN DOG NO. 1 F

Time Tests Made		Blood Flow Per Minute in C.C.	
Hours	Minutes	R	L
3	30	9.375	20.000
4	00	7.058	18.461
4	30	6.857	16.000

polymorphonuclear neutrophilic leucocytes was higher, the intensity of small round cell infiltration more pronounced, and the subsequent healing of the tissue defect much more rapid on the side on which the cervical sympathetic chain had been removed than the contralateral lobe.

Concerning the influence of the sympathectomy upon the healing of a defect in the bone, several conflicting clinical observations have appeared in the literature. Thus, Kappis in 1923 performed Leriche's operation in a case of delayed union of the fracture of the lower leg and obtained no beneficial result. Similarly in 1924 Rieder

obtained a negative result in his case. In the same year Rubaschow published his report on 3 cases in 2 of which the results were favorable, and in 1 negative. In the experimental field Mariano has observed a more rapid healing of the fracture on the side of the sympathectomy in the rabbits.

Uno in our laboratory produced a fracture on both hind-limbs in 25 dogs. In 13 animals he had performed a unilateral Leriche's operation and in the remaining 12 extirpated ganglionated cord between the second or third lumbar and first sacral regions on one side. Comparison of the results of these series of experiments showed (1) that of the 13 Leriche treated animals, there was a pronounced acceleration of healing processes in 6, moderate acceleration in 5, and no definite benefit in the remaining 2 cases, and (2) that in the 12 cases in which lumbosacral sympathectomy had been performed, there was a decided enhancement of the healing in 11 cases, and (3) that the latter procedure caused not only more constant beneficial result, but that the degree in which the healing was promoted was definitely more intense than in the first series.

CLINICAL OBSERVATIONS

While the experimental studies briefly summarized here were going on, Osawa, at the suggestion of one of us (Ito), perfected the technique of operation for the removal of the lumbosacral sympathetic chain in man, and the first available case of a patient operated upon occurred on Jan. 21, 1925. On April 2 of the same year he had reported on 2 patients having thromboangiitis obliterans with gangrene upon whom he had operated, at the meeting of the Japan Association of Surgeons. In 1926, 8 additional cases of thromboangiitic gangrene and 3 cases of patients having chronic suppurative osteomyelitis operated upon by Osawa were reported. At the general meeting of the Japan Medical Association for the same year one of us (Ito) presented a somewhat com-

prehensive survey of the surgery of the sympathetic nervous system, and reported on 9 cases of bronchial asthma, 11 cases of idiopathic epilepsy, 3 cases of Graves' disease, in all of which cervical sympathico-ganglionectomy was performed, 10 cases of chronic suppurative osteomyelitis, 1 case of varicose ulcer, and 15 cases of thromboangiitis obliterans with gangrene or intermittent claudication, in which lumbosacral ganglionectomy was performed, together with 36 cases of thromboangiitis obliterans, 2 cases of chronic ulcers of the legs, 1 case each of varicose ulcer, syphilitic ulcer, and tuberculous arthritis in which Leriche's operation was done.

Since then the number of patients operated upon has considerably increased, and the field of application of the lumbosacral sympathico-ganglionectomy extended until we have records at present of a little over 30 cases of thromboangiitis obliterans, 4 cases of Raynaud's disease, 8 cases of postapoplectic spastic hemiplegia and other types of cerebro-spastic motor disturbances. Among these the most decided improvement was obtained in Raynaud's disease, thromboangiitic gangrene, intermittent claudication and in chronic osteomyelitis. In cerebrospastic cases the results were uncertain except in 1 case in which the spastic hemiplegia followed a traumatic laceration of the parietal lobe and the symptoms were improving at the time of the operation.

We are interested at the present communication in those trophic disturbances of the lower extremities which were classified by Buerger as thromboangiitis obliterans and for which we had had no remedy other than amputation, the most tragic of the cases requiring multiple amputations involving one, two, three and even all of the extremities in order that life be sustained.

BRIEF OUTLINE OF CASE HISTORIES AND PHYSICAL FINDINGS

As has been previously stated, our chief interest in the present communication lies

in the presentation of the cases belonging to the symptom groups of intermittent claudication and spontaneous gangrene which were treated by abdominal sympathectomy, and no extensive clinical analysis of the disease will be attempted, until a further accumulation of cases similarly treated will enable us to formulate our idea more firmly.

The symptoms of intermittent claudication are weakness and pain in the calf muscles or foot upon walking, which disappear after a short rest, only to recur upon resumption of exercise. Pain, coldness, or numbness may first be felt in the forepart of the foot, in the region of the calcaneus, or in one of the toes. Of the 27 cases tabulated (see Table VII), 14 belong to this group. Over 20 additional cases of this group were observed by us, but since these had been treated by Leriche's operation they are not included in this table. Only 1 case so treated, however, is included in order to emphasize the fact that in certain cases the periarterial operation has a definite indication.

Age: Of the 14 cases, the youngest was twenty-six and the oldest fifty-four, the average age being thirty-nine years and six months. Since the average duration of the symptoms in these cases is seventeen months, the average age of incidence is approximately thirty-eight years.

Sex: Of the 14 patients, 11 were men and only 3 women.

Heredity: In a few instances tuberculosis and cerebral apoplexy were noticed in family history, and psychopathy in one. But these instances are no more frequent than in any other equal sized groups of individuals.

Habits: Although no excessive indulgence was noted, yet among the male patients, there was only one total abstainer from alcohol and tobacco.

Previous Illnesses: Among the 14 patients, there were 4 in whom suggestive history of the initial lesion of syphilis was noted, but none of them showed any evidence of secondary lesion, and the serum reaction

has been uniformly negative. History of previous nephritis was obtained only in 1 case.

Occupation: A large majority of the patients were farmers. From the type of farming in our country it was thought possible that the continued exposure of the extremities to water in rainy season in planting rice stalks may play some definite rôle in etiology. In 1 case (Case XI) a close connection was noted between the onset and the exposure of the lower extremities to water in the rice field during planting season, the initial symptoms appearing soon after the closure of the season.

Symptoms and Course: The initial symptoms occurred without apparent cause in all but the eleventh case, consisting of pain in the calcaneus upon exertion, such as walking or lifting heavy objects, a weakness or dull ache in the calf, or similar symptoms in the foot or toes, and rarely in the thighs or hands. The symptoms are usually progressive with a gradual intensification of complaints. Periods of remission are, however, frequent, during which the patients remain free from the symptoms or the intensity of the symptoms remains reduced. Chilling the extremities intensifies the symptoms, while warming relieves them to a considerable extent.

Physical Findings: Examination reveals no gross disturbance of sensibility or motility. Muscular atrophy of the affected limb is noticed only in long-standing cases, and even in these it is not pronounced. The skin of the affected limb is usually colder to the palpating finger than the opposite limb, and there may be pallor, cyanosis, or rarely livid red coloration of the dorsum of the foot. The last sign was encountered only once in our series. The cyanosis is frequently most marked in toes, and especially in the nail-bed. The pulsation of the dorsalis pedis is usually weaker on the affected side than the contralateral healthy limb, but the popliteal pulsation is seldom so affected, occurring only once in the present series.

TABLE VII

	Patient's Name	Sex	Age	Duration of Symptoms	History	Physical Findings	Results
I	M. T.	M	34	5 mos.	Pain in left calcaneus, forepart of left foot, sense of tightness in left calf, coldness in the sole of left foot, especially upon walking	Pulsation of the left popliteal artery slightly smaller than right; of the left dorsalis pedis difficult to palpate	General improvement. Pulsation of left dorsalis pedis slightly augmented. No symptoms
II	Y. A.	M	35	7 mos.	Weakness of left thigh, left arm upon walking. Recently similar symptoms on right, walking causing a drawing pain in right thigh. Symptoms on left side not marked. Coldness in right leg	Coldness and pallor on left foot. Pulsation of the right dorsalis pedis weaker than left	Complete disappearance of symptoms
III	E. H.	F	54	6 mos.	Pain in right leg upon walking, coldness in both legs. Pain intensified upon continuation of walking, extending to right foot	An ulcer the size of the tip of small finger in the middle of right tibial surface. Pulsation of right dorsalis pedis weaker on right	Disappearance of symptoms; complete healing of ulcer
IV	E. I.	M	32	8 mos.	Frost bite of left second toe took 80 days to heal. Ever since a sensation as if electric current is passing through left foot and leg when exposed to cold. Pain in left calf upon walking	Left calf slightly smaller than right; left leg colder to touch, especially the foot. Left dorsalis pedis shows weaker pulsation	General improvement with disappearance of symptoms
V	K. I.	M	43	2 yrs.	Coldness in the left foot, weakness and drawing pain in left calf on walking, disappearing after a short rest	Skin on left leg paler than right, also colder to touch. Pulsation of left dorsalis pedis weaker	Improved with disappearance of symptoms
VI	T. F.	M	40	3 mos.	Weakness and dull pain in left calf, intensified by continuous walking, abating after a short rest	Pulsation of left dorsalis not palpable. Left foot cold to palpation and pale	Complete disappearance of symptoms
VII	Y. H.	M	35	1 yr. 4 mos.	Cold sensation, dull ache, sense of tension in left calf, intensified by continuous walking and holding the leg high. Recently right side similarly involved	Left leg slightly atrophic; skin colder and paler on left. Pulsation of left dorsalis pedis difficult to palpate	Disappearance of symptoms and increase of skin temperature of both legs after bilateral operation
VIII	B. Y.	M	52	3 yrs.	Weakness and dull pain in left calf, intensified by walking. After short rest able to resume locomotion. Cold feeling in the left leg and foot, whether resting or walking	Below middle of left lower leg, skin definitely colder than on right; left calf muscles tender to palpation. The left dorsalis pedis pulsating very weakly	Disappearance of symptoms
IX	T. S.	F	42	2 yrs.	Coldness and weakness on left calf on walking	Pulsation of left dorsalis pedis barely palpable. Skin cold to touch	Complete disappearance of symptoms
X	K. M.	M	36	2 yrs.	Left foot cold and painful on walking, ability to walk becoming gradually limited to shorter distance. Pain especially intense in 4th and 5th toes on left foot	Dorsum of left foot slightly swollen. Cyanosis of left foot especially marked on 4th and 5th toes. Pulsation of left dorsalis pedis difficult to palpate	Complete disappearance of symptoms
XI	T. T.	F	26	6 mos.	After working in water for nearly a month, right lower leg became edematous and weak. Pain in left calf and weakness of toes	Left foot colder to touch than right. Left toes show pigmentation. Left dorsalis pedis difficult to palpate	Improved after periarterial sympathectomy
XII	M. T.	M	43	3 yrs.	Pain in right foot and calf upon walking, relieved by rest	Dorsum of right foot livid red, also hyperesthetic. Pulsation of right dorsalis pedis weaker than right	Complete cure
XIII	S. F.	M	39	1 yr. 10 mos.	Weakness of left calf; pain, numbness, coldness in left great toe at onset. In February of this year severe pain under nail of left great toe; nail removed with resulting increase of pain. Since months ago weakness in right leg and foot with sticking pain and coldness	Left leg slightly smaller than right. Left foot generally pale and cold. Left great toe shows cyanosis of nail bed and is very tender. Right foot cold but shows no abnormal color. Pulsation of both dorsalis pedis weaker, but more marked on left side	Improved with disappearance of symptoms after bilateral operation

TABLE VII (Continued)

	Patient's Name	Sex	Age	Duration of Symptoms	History	Physical Findings	Results
xiv	S. N.	M	43	1½ yrs.	Weakness and pain on walking in left calf relieved by resting. Coldness in left leg and more especially in foot	Left popliteal artery shows a somewhat weaker pulsation. Pulsation of the left dorsalis pedis is not palpable	Improved with complete disappearance of symptoms
xv	M. H.	M	48	5 yrs.	At onset both hands and fingers became livid red in lifting heavy weight, becoming normal upon stopping exertion. No sensory disturbance then. Since then, at intervals of from 5 months to a year, the tip of left small finger, right 4th toe, right small finger and right great toe became involved in gangrenous process and either dropped off or were amputated on account of pain. The right great toe is still gangrenous and painful	Radial pulsation hardly palpable on both sides. Fingers that remain are dry, nails irregular, lusterless. Nail-bed of left index finger shows a small necrotic mass. Hands generally cold. Feet cyanotic, toe nails irregular and lusterless. Right great toe shows a sharply demarcated necrotic area from basal index distally. Pulsation of right femoral artery weaker than left; popliteal pulsation difficult to palpate on right, much weakened on left; from posterior tibial distally no pulsation found	No return of pulsation in occluded vessels, but considerable symptomatic improvement. No spontaneous pain. Able to walk two blocks before slight pain felt in the lower extremities, lower legs and feet warm
xvi	T. T.	M	50	5 yrs.	Onset with intermittent claudication. 1½ years ago left 5th toe amputated for continuous sticking pain. 7 months ago left great toe amputated for similar symptom. 18 days prior to admission the stump of the great toe became ulcerated and painful	Left foot anemic and slightly atrophic. Amputation stump of left great toe ulcerated, showing pale granulation which does not bleed on manipulation. Surrounding skin necrotic and dirty. Left leg and foot colder than right. Pulsation of left femoral artery weaker than right. Left popliteal, dorsalis pedis do not pulsate	Result not satisfactory after left-sided lumbar and Leriche's operations
xvii	T. Ta.	M	32	8 mos.	6 years ago the nail-bed of the right great toe suppurated and healed by removal of the nail. Later serous fluid accumulated at same place and took 100 days to heal. 8 months ago suppuration again occurred in the same toe which does not heal. After his walking about 10 blocks the sleep that night is disturbed by pain on the toe	Nail-bed of right great toe presents a yellowish crust. Dorsum of right foot and toes cyanotic, except 5th toe. Nails of other toes on right foot deformed and wavy. Pulsation of dorsalis pedis not palpable	Improvement with disappearance of symptoms and discoloration except right great toe which turned livid red
xviii	S. M.	M	42	2 yrs. 3 mos.	Reddening of the left great toe after exercise. 2 months later left first and second toes were injured and healed after prolonged treatment. 2 months later began to feel an intense pain in right foot on walking a block. Right great toe became gangrenous and was amputated	Great toes both sides and fifth toe on left show nicely healed amputation stump. Pulsation of dorsalis pedis is not palpable on either side	A slight pain occurs upon walking about 3 blocks, relieved readily by short rest
xix	Y. N.	M	42	2 mos.	After repeated exposure of feet to cold water in the river, the right great toe became cyanotic, cold, and painful. 20 days later 2nd toe similarly involved, the root of the nail becoming blackish and dry. A few days ago right 3rd toe became livid red on its medial surface	Right great toe livid red, its tip excoriated. 2nd toe shows the nail-bed, proximal half of the nail and terminal phalanx blackish, very tender, the discolored area being sharply demarcated. 3rd toe cyanotic in its medial surface. Right foot generally cold to palpation. Pulsation of the right dorsalis pedis not palpable	Complete cure after combined lumbar and Leriche's operations
xx	M. K.	M	23	3 yrs.	Onset with excruciating pain in left great toe without cause, relieved by prolonged treatment at hot springs. Since a year ago similar symptom in 1st, 2nd, and 4th toes and back of left foot. A month later right great toe also painful, abated after 3 months. Left side became worse and gangrenous process started. Leriche's operation on both sides a year ago with relief of pain and gangrene. Since 10 days ago right lower leg cold, 2nd and 3rd toes gangrenous and painful	On right great toe bone exposed by necrosis at middle phalangeal joint. Tips of 2nd and 3rd toes dark red and partly necrotic, 4th and 5th toes dark red and dry. Right dorsalis pedis does not pulsate	Improvement with disappearance of symptoms and healthy granulation of wounds

TABLE VII (Continued)

	Patient's Name	Sex	Age	Duration of Symptoms	History	Physical Findings	Results
XXI	H. M.	M	34	3 yrs.	Right great toe was struck while at tennis match, nail-bed inflamed for a few days. 2 months later same toe suddenly painful, and continued painful for 30 days necessitating amputation of the distal phalanx, entire toe, and 3 months later of the lower half of the leg. 3 months ago sticking pain of the tips of left foot, depth of the sole of the foot, and dull ache in left calf on walking. Since a month ago tips of left toes livid red, cold and painful	Distal half of the left foot quite cyanotic on dorsum. Entire great toe livid red. Entire lower leg cold to touch, tips of foot especially so. Pulsation of right femoral artery weaker than left. Both dorsalis pedis do not pulsate	Left foot slightly red; no cyanosis, no spontaneous pain. Complete cure
XXII	H. K.	M	47	5 yrs.	Thumbs of both hands became cyanotic and cold in winter, soon afterwards tips becoming ulcerated and painful. Relieved after prolonged treatment at hot springs. Several months later right great toe became gangrenous and amputated above ankle. Since 3 years ago left small toe became cyanotic, cold, painful. 3 months ago its tip became ulcerated and blackish after slight injury and shows no tendency to heal	The proximal phalanx of the left small toe bared and its base represented by an ulcer the size of 50 cent coin. Edge of ulcer swollen, base livid red, surrounding skin blackish. Pulsation of dorsalis pedis not palpable. Tips of toes generally cold and cyanotic	Complete cure after lumbar operation and removal of necrotic bone
XXIII	S. N.	M	23	6 mos.	After a small wound inflicted in the right small toe healed, a dull pain felt in the sole of right foot upon walking. 3 months ago the right great toe twisted in stumbling, the toe swollen, the sole of the foot discolored blackish. Pain prevented sleep. A month ago nails of 1st and 5th toes removed for pain without relief. The small toe blackish ever since and pain intense	Dorsum of right foot edematous, red and hot. Great toe generally black, and around discoloration skin eroded, cyanotic, painful. 5th toe totally necrotic. Rest of the toes cyanotic. Right popliteal artery, dorsalis pedis show no pulsation. Body temperature 39.3°C.	No improvement
XXIV	S. Na.	M	44	1 yr. 2 mos.	Pain in both legs, especially intense on dorsum of feet at onset. 10 days later both hands and fingers became painful. In 2 months pain intensified and in left foot constant. 3 months ago both feet became cold, both great toes livid red, and pain prevented walking. No pain in hands at present. Pain in right foot occasional, on left constant	Left great toe livid red; ulcer 1 cm. in diameter on its dorsal aspect discharging purulent exudate. The rest of the toes edematous. Both feet cold to palpation. Dorsalis pedis does not show pulsation on either side. Popliteal pulsation palpable	Left foot symptomless, ulcer granulating nicely. Right also symptomless
XXV	C. Y.	M	41	13 yrs.	Symptoms of intermittent claudication merged into gangrene of the right foot. The numerous sites of injections on the leg became ulcerative and did not heal. Right leg amputated at middle of thigh 2 years after onset. 1½ years ago similar symptoms appeared on left side, pain gradually localized to the foot. 2 months ago toes became violet red, cold and painful	Right thigh shows nicely healed amputation stump. On left side 3rd toe is livid red, tender to palpation. Other toes show no abnormal coloration. Ankle region somewhat swollen diffusely. Foot is abnormally cold to palpating hand. Dorsalis pedis shows no pulsation	Although around nail of the left 3rd toe is slightly cyanotic, condition much better than before operation. No pain. Pulsation of dorsalis pedis barely palpable. Otherwise much improved after left-sided lumbar sympathectomy
XXVI	T. I.	M	51	18 yrs.	First attack with dull pain, livid red coloration in 5th toe of the right side, amputated. Soon afterwards right great toe amputated for same reason. 8 months ago right middle finger was amputated for similar symptom. 4 months ago right 2nd, 3rd, 4th toes became similarly involved, 4th healed, 2nd and 3rd remain ulcerated and painful	Pulsation of arteria dorsalis pedis not palpable on right side. On the right side, 5th toe absent. Amputation stump of the great toe shows a healthy granulation. 2nd and 3rd toe ulcerated and infected, discharging seropurulent exudate. 3rd toe shows exposed semi-necrotic bone. Extremely tender	Ulcers on the 2nd and 3rd toes granulating nicely, right foot definitely warmer than left and pain is practically absent

TABLE VII (Continued)

	Patient's Name	Sex	Age	Duration of Symptoms	History	Physical Findings	Results
xxvii	S. O.	M	26	5 yrs.	At first dorsum of right foot felt cold, painful, and swollen; the epidermis at the tip of great toe became thickened, and discolored brown. A year later upon walking about 2 miles the right leg became tired, foot painful and cold; on right calf and dorsum of foot veins swollen and painful. Left leg became similarly involved since 3 years ago. Recently it has become impossible to walk over two blocks without rest	On both lower legs veins dilated and tortuous. Both feet are cyanotic in their distal halves, toes especially so. Tip of right great toe necrotic, left great toe necrotic distal to the 2nd joint. Both lower legs and feet clearly cold to palpation. Both femoral and popliteal arteries are felt to pulsate, pulsation of dorsalis pedis not palpable	Both feet barely cyanotic, right great toe healed, left great toe nicely granulating. General improvement. Dorsalis pedis not palpable, but both feet are warmer

Hyperesthesia of the skin of foot and of the calf muscle was noted in a few cases.

Of the 14 cases, bilateral involvement was found in 4, in 2 of which the complaints remained only on one side at the time of admission.

The term spontaneous gangrene is applied to those cases of thromboangiitis obliterans in which the pulsation of the dorsalis pedis artery is absent, and that of the posterior tibial or popliteal artery is also either absent or weakened, on the affected side. Very rarely even the pulsation of the femoral artery may be found weaker than on the healthy side. The clinical picture is consequently that of deprivation of nutrition of the affected part caused by occlusion or narrowing of the arterial tree, such as cyanosis, coldness, paresthesia, pain, ulceration and gangrene. In practically half of the cases the initial symptoms were those of intermittent claudication, with pain, cyanosis or reddening of the toes, foot or calf. In the rest of the cases, the initial attack was ushered in with pain in one of the toes or in the nail-bed, most frequently of the great toe. In 1 case coldness and pain of the dorsum of the foot was the first symptom. In 2 cases both hands and fingers were initially involved, the lower extremities becoming affected subsequently. Livid red discoloration was noted in all those cases showing ulceration or necrosis and was the first symptom to attract the attention of the

patient in 1 case. Repeated exposure to cold water preceded the onset in 1 case, and trauma in 2 cases, but in the large majority of patients no apparent exciting cause was noted.

Following the appearance of the initial symptoms, a rapid fire involvement of other members of the limb with pain, cyanosis and necrosis occurred in 2 cases. Usually, however, a period of from two months to a year or two years intervened between the initial and the later more pronounced symptoms. A tragic history of repeated amputations noted in several of these patients is typical and represented the helplessness of the profession in combating this intractable malady.

Age: Of the 13 patients the youngest was twenty-three years and the oldest fifty-one, the average age being 38.7 years. The shortest duration of the illness was two months, the longest eighteen years, the average duration being 4.1 years. The average age of incidence was 34.6 years.

Sex: All of our patients were men.

In occupation, habits, and previous illnesses, there is practically no difference from the intermittent claudication group.

Examination reveals, in accordance with the history, evidences of the past and present trophic disturbances of various grades, from the previous amputation stumps with complete healing of wounds, ulcerated stumps, gangrene of the toes or foot, with or without secondary infection

to livid red discoloration, cyanosis, and ulcers of the skin. The pulsation of the dorsalis pedis artery of the affected limb is most commonly absent, rarely barely palpable. The popliteal artery was occluded in 2 cases, while the pulsation of the femoral artery was weaker on the affected limb in 1 case. The involvement was bilateral in more than half of the cases, but it was rare to find both sides involved simultaneously.

TECHNIQUE OF THE OPERATION

After the usual preparation for laparotomy, the patient is placed on the operating table in a moderate Trendelenburg position. A median longitudinal incision is made extending from about two fingersbreadth above the umbilicus to the symphysis pubis. The coils of the small intestine are gently lifted out of the abdominal cavity and wrapped in the towel moist with the warm physiologic salt solution. The posterior parietal peritoneum is picked up with a pair of anatomical forceps over the promontorium and is opened up and down with the promontorium as the midpoint for a distance of about 8 cm. along the midline. Depending upon whether it is desired to remove the right side or the left, the peritoneal fold is displaced to the right or left. The abdominal aorta bifurcates in front of the body of the fourth lumbar vertebra, the inferior vena cava also bifurcates at the same level but immediately posterior to it, and the ureters which course behind and lateral to the aorta descend along the anterior surface of the iliopsoas muscles and pass in front of the iliac arteries near their bifurcation. Now, since the sympathetic chain lies posterior to all these structures on either side, it is necessary first to dissect off all the soft tissues surrounding these vessels. The first sacral ganglion which is the largest in the lower abdomen is now exposed. The ganglion is now gently lifted up from its bed by means of an aneurysm needle, and is freed from the surrounding tissues bluntly with a

thyroid probe, and the rami communicantes are divided with a pair of scissors with the least possible traction upon them. By following the sympathetic cord from the ganglion upward the lower lumbar ganglia are easily located. These are freed from the surrounding tissues and their rami divided exactly as in the case of the sacral ganglion. Between the third to the fifth lumbar vertebrae there are found usually two ganglia, occasionally only one. The cord immediately above the ganglion at the third lumbar vertebra is now divided, also that immediately below the first sacral ganglion, and the cord and the ganglia removed in a continuous chain. Occasionally it is found difficult to dissect the blood vessels free, in which event the sacral ganglion is extirpated separately from the lumbar ganglia.

The posterior parietal peritoneum is now closed, the intestinal coils returned into the abdominal cavity, and the wound closed in layers.

It is perhaps not without purpose to mention the fact that in our earlier practice the second lumbar ganglion was also removed. However, it was noted that this procedure greatly favored the development of postoperative flatulence, and since there is no necessity to remove it for the therapeutic purpose, we have abandoned the practice.

Adson appears to approach the sympathetic chain on the left side by dividing the posterior parietal peritoneum to the left of the sigmoid colon, and retracting it towards the right. Such a procedure would not only be cumbersome but also tend to disturb the circulation and innervation of the sigmoid. This is the point in which our respective methods differ, and in our opinion Adson's method of approach is wholly unnecessary.

RESULTS OF THE OPERATION

Of the 27 patients operated upon, there was a decided improvement in the conditions of the affected limbs except in 2 cases in which the pulsation of the femoral

artery was decidedly weaker on the diseased limb than on the opposite side, the parts of the artery distal to the posterior tibial artery being completely occluded. In these 2 cases the skin of the affected parts remained as cold after the operation as before. In the successful cases, on the other hand, there was an immediate and often decided elevation of the cutaneous temperature, as judged by palpation and thermometry. In the first group of cases (intermittent claudication with no complete obliteration of the dorsalis pedis), the skin of the operated side became definitely warmer than the healthy side, and remained warmer until the time of discharge, which was in some cases longer than two months after the operation. In the second group of cases of spontaneous gangrene with complete occlusion of the dorsalis pedis artery, the skin became warmer compared to the pre-operative condition but not warmer than the healthy side. In the first group it was the rule for the symptoms of pain, coldness, and weakness upon exertion to disappear completely. In 1 of these cases in which an ulcer was found on the anterior surface of the tibia, the ulcer rapidly granulated and healed in the first six days of the operation. In the second group of cases, with return of warmth there was general improvement with disappearance of pain, rapid healing of ulcers with granulation and epithelialization, and loss of abnormal coloration of the skin, such as cyanosis and livid reddening. As the table shows, of the 11 successful cases there was only 1 case in which removal of necrotic bone was necessary, in the remaining 10 cases semi-necrotic limb becoming healthy looking. In 2 of the successful cases of this group, a slight pain upon walking for several blocks remained after the operation, and the cyanosis of the most affected toe remained in 1 case.

The pulsation of the dorsalis pedis was generally strengthened after the operation in the first group of cases, while in the second group such an effect could not be

detected even in successful cases. The elevation of the cutaneous temperature in the first group with no complete obliteration of the artery may, therefore, be attributed to the vasodilatation resulting from the operation, whereas in the second group the beneficial result obtained must be traceable to widening of the collateral channels through which an increase of circulation was perhaps effected. That a definite increase in blood flow was obtained even in those cases in which the occluded dorsalis pedis could no longer be dilated, is shown by the elevation of the skin temperature and the accompanying symptomatic improvement, as well as the definite reduction of the time required for the positive Mosckcowitz's hyperemia test.

Of the first group of cases of thromboangiitis, 13 were treated by our method of lumbar and lumbosacral sympathico-ganglionectomy, and 1 by Leriche's operation. The latter case was so treated on account of pregnancy advanced to fifth month, in which case the abdominal operation would be not without danger of abortion. In the remaining cases, the cure was practically complete. A few of the cases are known to the author to be still free from symptoms three and four years after the operation. Of the second group of cases, 1 (Case xx) had received a temporary benefit for four months following Leriche's operation for spontaneous gangrene, but after subsequent lumbosacral sympathectomy, there has been no return of the symptoms now for over three years. In advanced cases, however, such a decided benefit is rarely to be expected, as later recurrences are likely to occur, necessitating amputation.

DISCUSSION

That in the vasospastic conditions such as Raynaud's disease any form of operation removing the vasoconstrictor fibers should prove effective there is no basis for doubt. Our limited experience fully confirms the conclusions reached by Adson, Davis and others. That in slow healing ulcers and osteomyelitis such a procedure

accelerates healing is also shown by the experiences of other writers as well as ours by abdominal sympathectomy. In these conditions, however, the cause of the beneficial effect is to be sought in dilatation of the existing blood channels in which organic alteration is not present. In thromboangiitis obliterans, especially of the stage of gangrene in which at least the dorsal pedal artery is occluded, it is surprising that the benefit derived from the operation should be as pronounced as we have here reported. The negative results in the 2 cases in which the occlusive changes involved the popliteal artery show, however, that in them a sufficiently extensive compensatory anastomosis does not form or that collateral channels are not adequate to permit an increase of blood flow. In those cases in which improvement in the clinical symptoms resulted, we feel justified in believing that the sympathectomy caused not only a dilatation of the existing collaterals but also a formation of new anastomosis.

The superiority of the removal of the sympathetic chain including the cord and ganglia over either ramisection or periarterial operation, we believe, is self-evident. There is a uniformity of opinion of the recent writers on the segmental distribution of the sympathetic fibers to the arterial tree, definitely limiting the value of Leriche's operation on a priori ground. The temporary and partial nature of the improvement obtained by periarterial operation is proved by the numerous clinical observations as well as by the experimental results briefly mentioned in our report.

Concerning the division of the rami communicantes it may be stated that not all of the fibers in the lumbar and lumbosacral sympathetic cord are derived from these lumbar and sacral rami but many of them descend from the overlying ganglia. The radical removal of the lower lumbar and possibly also upper sacral ganglia and cord must be much nearer the satisfactory form of operation, there-

fore, than either of these methods mentioned.

THE RÔLE OF SYMPATHETIC INNERVATION ON MUSCLE TONE

The doctrine of double tonic innervation of the skeletal musculature of de Boer and Langelaan, although stoutly supported by Royle, Kuntz and Kerper and many others, has not yet found any positive evidence for its support. Langelaan, and Hunter and Royle especially maintained that sympathetic innervation has to do with the upkeep of the plastic element of the muscular tonus. Numerous experimental results of Ranson and Hinsey, Iwata and others show that the plastic element in decerebrate rigidity is not influenced by sympathectomy. Recently one of us (Asami) has shown that in the rabbit a unilateral extirpation of the lumbar sympathetic chain does not diminish the force or amplitude of the knee-jerk, that its faradic stimulation does not enhance the knee-jerk, and that the degree of hypotonia and reduction of the knee-jerk occurring as the result of spinal transection is not influenced in the least by the presence or absence of the lumbosacral sympathetic chain. The unilateral sympathectomy performed on the dogs resulted in a similarly negative way in our hands.

A recent report by Fulton upon a pronounced and long-standing reduction of the knee-jerk and muscular resistance following lumbar ramisection performed by Royle is striking. Fulton's description of the state of the musculature of the operated side coincides beautifully with the picture of atonia described by Holmes in cerebellar injuries. Such a fact, if it occurs in many cases, would be difficult to explain upon any other ground than the double innervation theory, Fulton's opinion to the contrary notwithstanding. Leriche's positive though incomplete report of 2 cases of spastic hemiplegia treated by ramisection and Royle and Kerper's report tend to be supported by such observations

as Fulton's. If such a prolonged (one year) reduction of the tonus is the normal effect of sympathectomy, then it would afford a great source of joy to many surgeons who are interested in the treatment of spastic limbs.

Unfortunately, in many hands, such a positive effect cannot be duplicated. In our hands, lumbosacral sympathectomy is followed in some cases by from a slight to a moderate reduction of the knee-jerk which becomes normal at latest in eleven days. Even during the period in which the knee-reflex remained reduced, there has never been found such a profound flaccidity of the muscles as Fulton describes. In the majority of the cases, furthermore, the reduction of the knee-jerk has been so slight that no definite difference between the two sides could be said to be demonstrable. In 4 cases of spastic hemiplegia, the operation proved beneficial only in 1, and that was the case of traumatic laceration of the parietal lobe and which was improving previous to the operation. In those cases in which the cervical sympathetic chain was removed on one side for bronchial asthma, epilepsy, Graves' disease, Raynaud's disease, and thromboangiitic gangrene of the hand, we have never found an evidence of muscular weakness. Our results agree fully with our experimental observations and with the statements which appear in the papers by Sachs, and Kanavel, Pollock and Davis.

What, then, is the reason for so wide a divergence of clinical as well as of experimental observations? Spiegel and Hotta have found in their experiments that traction upon the rami communicantes during the operation greatly reduces the muscle tonus, due, in their opinion, to a "shock" affecting the spinal reflex arc. In our work we are positive that the traction exerted upon the rami has been minimal. Fulton states that in the patients operated on by Royle, the shoulder muscle underwent a wasting and hypotonia due to an injury

to the brachial plexus perhaps in the maneuvers of retraction. In line with Spiegel's argument, we doubt to what extent the so-called tonus reduction following the operation by the ramisectionists, such as Royle and von Lackum, may owe its genesis to similar injury in the operation. It is our plan to report in subsequent communications the result of deliberate traction upon the rami communicantes and compare it with the results obtained by our usual method.

SUMMARY AND CONCLUSION

1. A clinical account of 27 cases of thromboangiitis obliterans is presented, together with a brief description of the technique of operation developed in our clinic in which the lower lumbar and upper sacral ganglia are removed with the intervening cord.

2. A brief description of the animal experiments performed in our laboratory, showing the definite increase in the volume flow of blood through the homolateral limb, and facilitation of wound healing, thereby, is given.

3. In the treatment of the symptom groups of thromboangiitis obliterans, apparently permanent and complete cure is obtained by the lumbar and lumbosacral sympathico-ganglionectomy in their earlier stage of intermittent claudication. With the development of gangrene and obliteration of the popliteal or tibial artery, on the other hand, the result of the operation is not satisfactory. Obviously, therefore, it should be our object to operate upon such patients at the earliest possible stage of the disease.

4. Clinical evidences contradictory to the doctrine of sympathetic tonic innervation of the skeletal musculature is presented. It is our aim to further elaborate upon these observations in the succeeding reports.

[For References see p. 62.]

CHRONIC HYPERTROPHIC VULVITIS

COMPLICATING PREGNANCY*

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THE inflammatory hypertrophies of the vulva have been described under a variety of names. Elephantiasis is the term commonly employed by the English. The French call it *esthiomene*, the Germans, *ulcus rodens vulvae*, while in America *syphiloma* is the term usually employed. Call the condition by whatever name you may, the underlying factors, according to Taussig,¹ are:

1. Blocking of the lymphatic return.
2. Prostitution or excessive sexual intercourse.
3. Lack of cleanliness or profuse irritating discharge.
4. Racial predisposition to skin hypertrophies.

The first factor may be brought about in a number of different ways. In the tropics infection with *filaria sanguinis* is frequently found. Chancroidal bubo, syphilitic adenitis, surgical resection of inguinal lymphatics or sclerotic scar tissue from chronic ulceration, particularly extending laterally from the urethra, are the more common causes in temperate regions. The disease is almost wholly confined to the lower strata of society and is said never to be seen in women of cleanly habits and good morals. Taussig's 13 cases were all negroes. European literature, however, shows that the other races are not wholly immune. Syphilis is by far the commonest precursor but usually the Wassermann test is found to be negative. Repeated salvarsan injections have no effect on the condition. For that reason Taussig thinks the term *syphiloma* is a misnomer. Tubercle bacilli have been found in some of the more recently reported cases. Nevertheless, Taussig is of the opinion that syphilis is the commonest factor in the blocking of

the lymph channels, but the infectious agent producing the ulcers may be any of a myriad that are found about the vulva. The essential factor after all is nutritional rather than an infection due to any specific organism. The irritation associated with lack of cleanliness is of importance in producing the hypertrophy. The course of the disease is slowly progressive. In one of Taussig's cases complicated by pregnancy there was marked edema with rapid increase in the size during pregnancy, followed by a rapid reduction in volume during the puerperium.

In the case recently reported by Kamniker¹ there was a rapid enlargement of the tumor in both the first and second pregnancies beginning both times at the fourth month. After the first delivery, which was normal, the tumor had reached its ordinary size, that of a hen's egg, by the sixteenth day. It was removed surgically in the second pregnancy.

The treatment is surgical. Prolonged rest, douches and general hospital care accomplish little. Although salvarsan accomplishes little in the treatment, yet after operation it and potassium iodide tend to hasten wound healing.

CASE REPORT

The patient, a colored married woman, thirty-six years old, entered St. Philip Hospital, August 12, 1927, on account of swelling of her vulva. She had first noticed the swelling four or five months previously. It caused her no pain and no discomfort until it had gotten so large as to be in her way.

Her family history was negative. Her present husband was well. Nothing was noted in the history about her first husband. The patient had borne five children by the two husbands. Her pregnancies and labors have

* Submitted for publication April 21, 1931.

been uncomplicated until now. Two of her children were living and well. One died when one day old. Two died of pneumonia when

The patient was kept in bed and the vulval masses were treated with antiseptic lotions, such as potassium permanganate solution.



FIG. 1.



FIG. 2.

several years old. The patient had never been sick except for childrens' diseases. She had not had scarlet fever, kidney trouble, acute rheumatism or any surgical operations. She had begun to menstruate at eighteen years of age. The periods occurred regularly every four weeks, lasted four days and were without pain. Her last menses began January 21 and had lasted the normal time.

Examination upon admission to the hospital was essentially negative except for a soft systolic murmur at apex, a rounded abdominal tumor, the size of a seven months' pregnancy, and tumors of the vulva for which she entered the hospital. Abdominal palpations showed fetus in left occipito-anterior position, with head floating above the inlet of pelvis. Fetal heart sounds were heard in the left lower quadrant and were 150 per minute. McDonald measurement was 28 cm.

No vaginal examination was possible on account of the tremendous swelling of the labia and prepuce (Figs. 1 and 2). These swellings were hard, not tender, and presented a number of small ulcerations. There was a very bad odor.

Her temperature rose usually to 99.5°F. or 100°F. in the afternoons. Blood pressure was 145/90. Urine was negative.

On August 27, the patient went into labor and in three hours and ten minutes expelled a stillborn, male child that weighed 4 lb. 1½ oz. (1854 gm.) and measured 17¼ in. (45 cm.). The placenta was expressed ten minutes later. There was no difficulty about the delivery and so far as we could tell no damage to the perineum. The patient had ⅓ gr. of morphine when her pains started but no anesthetic. The puerperium was uneventful except that her temperature ran about the same course as it did before the delivery.

The patient was seen by a number of syphilographers and dermatologists. A tentative diagnosis of granuloma inguinale was made by them and a search was made for Donovan bodies, but none found. Nevertheless, the patient was given intensive treatment with tartar emetic. Between September 24, and October 22, 1927, the record shows that at least 7 doses of 5 c.c. of a 1 per cent solution of tartar emetic were given intravenously, with apparently no effect. The patient continued to run a little elevation of temperature in the afternoon. Blood examination at this time (October 25, 1927) showed hemoglobin

50 per cent, red cells, 2,060,000; white cells 9000 with 81 per cent polynuclear neutrophils. Blood counts at weekly intervals showed very little change. Blood culture was negative (Sept. 10, 1927). Blood Wassermann test was negative (Nov. 18, 1927).

On December 16, Dr. C. R. Robins removed the tumors. The temperature became normal in a few days and remained so. The wound healed well and the patient was discharged January 19, 1928, apparently well.

Pathological report by Dr. Charles Phillips is as follows:

Three tumor masses weighing in all 1897 gm. Largest mass is $19 \times 19 \times 8$ cm. and weighs 1000 gm. It is covered with skin except in some ulcerated areas and is rough, irregular and somewhat scarred resembling a keloid. Where excised from body, tissue is very edematous. Its interior shows a large abscess cavity 8×2 cm. filled with purulent hemorrhage and necrotic material. Near excised margin there is some fat. Second mass is like the larger mass except in size. The smallest mass a three-lobed keloid measuring approximately $6.5 \times 5 \times 2.5$ cm.

Microscopically this tissue appears to be edematous keloids with dense connective tissue stroma, infiltrated widely with a chronic inflammatory reaction. The diffuseness of the lymphocytic masses and their relationship to blood vessels rather suggests syphilis but proof of this is lacking.

Diagnosis: Three keloid masses, edematous, infected and showing on surface of two of them typical condylomata lata with ulceration.

Subsequent History: On April 3, 1931, I found the patient in her home. She said she felt perfectly well and had had no trouble from the operation. Since leaving the hospital she says, her only complaint has been rheumatic pains in her legs which her husband cured by twisting a loop of copper wire about her ankle. At the right corner of her mouth there is a circular, raised nodular lesion about one cm. in diameter. The patient has had this since last November. It has caused her no trouble and she has had no treatment for it. The right

upper gum was swollen and red, and slightly ulcerated to the inner side of the bicuspid teeth.

COMMENT

The case reported presented huge bilateral inguinolabial masses and a smaller clitoris type hypertrophy. Their growth was rapid, as the masses were first noted by the patient only four months previous to admission to the hospital. The pregnancy may have accounted for this rapid growth. On the other hand there was no diminution in the size of the tumors in the puerperium as was seen in Taussig's and Kamniker's cases. A diagnosis of granuloma inguinale was made by syphilographer consultants and a search was made for Donovan's bodies but in vain. Moreover, repeated injections of tartar emetic had no effect upon the disease. The blood Wassermann test was negative, but the patient gave the history of one baby dying a few hours after delivery and the present pregnancy ended in a premature stillbirth. Unfortunately no autopsy was obtained on this baby. The patient now has chronic lesions at corner of mouth and on the roof of the mouth. The remarkable thing from the standpoint of the obstetrician was the ease of the labor. No one who saw the patient believed that a spontaneous delivery was possible, and while we were discussing the relative merits of a vulvectomy at the time or a cesarean section at term, the patient went into labor prematurely and delivered herself unaided with surprising ease.

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BLOOD TRANSFUSION

ITS IMPORTANCE IN THE PRACTICE OF OBSTETRICS*

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DURING the past fifteen years marked progress has been made in protecting the obstetric patient during both her pregnancy and her labor. A more thorough and scientific supervision of each case throughout pregnancy combined with improved facilities for handling the ordinary complications, as well as for meeting the more disastrous emergencies has done much to increase this protection. Here I wish to speak of one of these facilities, the value of which has been fully proved, namely blood transfusion, and to discuss in a general way, without entering into technical or controversial points, the 4 important conditions in which it is indicated.

Blood transfusion, while it has a universally recognized value in treating medical and surgical cases, is, all too often, looked upon in the practice of obstetrics, as a means of helping the patient who has had a post-partum hemorrhage. This is unfortunate, for its field of usefulness is far greater. The technique of blood transfusion is so generally understood and the procedure is so frequently employed in all hospitals that it should be used oftener in obstetric conditions during both pregnancy and labor. With a careful cross-typing of donor and recipient, the patient rarely experiences any reaction, and should such occur, it is of short duration and does not in any way lessen the value of the procedure. At the Woman's Hospital we feel that there are 4 important indications for giving blood transfusions to obstetric patients. These are anemia of Pregnancy, placenta previa, post-partum hemorrhage, and puerperal infection. This means that blood transfusion is employed as a prophylactic measure as well as an imperative

procedure during an emergency, and that its use is of frequent occurrence.

In the last 2000 consecutive deliveries on the Obstetric Service, covering nearly four years, 82 blood transfusions have been given to 69 women, or 34.5 women in each 1000 were transfused. The most frequent indication was anemia. Among the 69 cases this was the sole indication in 36. In none of these 36 was there associated a post-partum hemorrhage as a cause for the anemia.

TABLE I

Indication	No. of Cases
Anemia without hemorrhage	36
Post-partum hemorrhage	25
Placenta previa . . .	5
Post-partum infection*	4

(From the Clinic of the Woman's Hospital.)

* One case included also under placenta previa.

1. *Anemia.* Of late years more and more attention has been given to the obstetric patient with anemia and various methods of treatment have been employed to overcome this condition. Anemia late in pregnancy is a real and frequently occurring condition and should be watched for. Thirty per cent of the patients, in a recent series of cases studied, reached term with a hemoglobin of 70 per cent or less. If such a number have this low hemoglobin, we must be on the alert if we are to do our full duty by these patients. Is not a woman with this degree of anemia a poor risk? Surely she cannot be expected to withstand a prolonged labor or a difficult delivery as well as one who has a normal blood picture, nor can she tolerate much loss of blood, without symptoms developing. The incidence of toxemia and syphilis is not sufficiently frequent among patients showing an anemia to be an important factor,

* Read before the Associated Physicians of Montclair and Vicinity, Montclair, N. J., October 24, 1930.

nor do repeated pregnancies seem to have much bearing. Rather it would seem that the high incidence of anemia in late pregnancy is not caused by or dependent upon the pregnancy per se but to a considerable degree represents a preexisting anemia associated with pregnancy. This anemia in nearly 50 per cent of the cases becomes more marked during the last trimester of pregnancy. Routine blood examinations will prove of great value and will materially help in insuring that the maximum number of cases reach term as good surgical risks. Diet, iron and other drugs benefit these patients to some extent but not sufficiently to place great reliance on them. We have, however, at hand a procedure which does give positive results in the minimum of time and with but little risk or inconvenience. At the present time a transfusion can be given so easily that patients should be protected whenever the need arises. Those women who have an abnormally low hemoglobin during pregnancy, should be transfused in order that they may reach term as good risks. The routine procedure in our prenatal clinic as well as in my private practice is to obtain a compatible donor for every patient who during late pregnancy has a hemoglobin below 70 per cent and have this donor stand by during delivery. Some member of the family can generally be found to render this service, and thereby insure the least delay, should a transfusion be needed. A patient delivered last July illustrates the need of transfusion in anemia:

On admission to the prenatal clinic at the end of her fourth month of pregnancy this patient had a red blood corpuscle count of 2,700,000 and a hemoglobin of 27 per cent. She was transfused and remained in the hospital five days. She was readmitted three months later with a R.B.C. of 3,200,000 and a hemoglobin of 40 per cent. She was again transfused, this time remaining four days. She was admitted in two months' time or when about eight and one half months pregnant with a R.B.C. of 3,500,000, hemoglobin of 45 per cent. She was transfused for the third time, remain-

ing in the hospital four days. She was admitted in labor two weeks later with a R.B.C. of 4,000,000, hemoglobin of 60 per cent. She had a normal labor, low forceps delivery, a tamponade of the uterus as a prophylactic measure and a loss of 125 c.c. of blood. There was no transfusion given immediately although the husband, being a compatible donor, remained outside the delivery room until the patient was returned to the ward. She was transfused on the third day post partum and left the hospital on the thirteenth day post partum with a R.B.C. 4,000,000, hemoglobin of 62 per cent.

TABLE II
SERIES OF 500 CASES AT OR NEAR TERM

Hemoglobin, Per Cent	Average R.B.C.	No. of Cases	Cases, Per Cent
90 or over	4,460,000	16	3.2
86 to 90...	4,480,000	29	5.8
81 to 85...	4,280,000	69	13.8
76 to 80...	4,170,000	125	25.0
71 to 75...	3,980,000	111	22.2
70 or below ...	3,540,000	150	30.0
Total		500	100.0

(From the Clinic of the Women's Hospital.)

Of the 36 women transfused for anemia 11 were transfused ante partum; 9 had one transfusion ante partum, 1 had two and 1 had three. These patients with a low hemoglobin ante partum are potentially poor risks during labor. While a patient, perhaps, does not require a transfusion before delivery, yet if she loses any appreciable amount of blood during or after delivery, she may be in urgent need of a transfusion. Such a patient is entitled to have the needed blood work done and a compatible donor found who will stand by during her delivery. Do not take it for granted that the markedly anemic patient probably will not bleed post partum and be caught with nothing ready. This may delay transfusion until the patient is exsanguinated. It is much more logical to be prepared and employ this procedure promptly and while the patient still has a reserve with which to work.

2. *Placenta Previa*. This is the second condition which I would like to discuss, a condition which for years has been most dreaded and rightly so. Great advance has been made in handling this complication and although still regarded as most serious, one does not meet it with the feeling of apprehension and often utter helplessness that formerly was so common. The employment of transfusions and cesarean section in combating this abnormality has greatly reduced the mortality of both the mother and child and given the obstetrician the feeling of confidence that something can be done that will not unduly jeopardize the life of the mother and will to a great extent insure a live baby. In this condition, the greatest risk both to the mother and to the baby is from hemorrhage and our chief concern must constantly be this risk. "Painless bleeding" in the third trimester of pregnancy should always make one most suspicious of placenta previa. The patient who phones she suddenly has had a flow of bright red blood, unaccompanied by pain, should be given consideration immediately and be seen at once. If she is actively bleeding when first seen, emergency measures must be used to control this, the best of which is a tight tamponade of the vagina with iodoform gauze. Therefore, when going to see an obstetric case with bleeding, always take a tube of gauze packing along. Usually this first flow of blood stops before the doctor arrives and the patient's general condition is not seriously impaired. Now is the time to act, before a second hemorrhage leaves the patient in a critical condition. The most natural thing is to examine the patient vaginally at once in order to make a diagnosis and determine whether there is a previa present. This vaginal examination, however, is the one thing which should *not* be done at this time; for the reason that if there is a previa the digital exploration of the vagina and the cervix is often sufficient to cause a most severe or even fatal hemorrhage. No vaginal examination or manipulation should be made on a case of

suspected previa, unless it is to stop hemorrhage, until every preparation is complete for controlling bleeding and for combating the attendant shock. Just what is meant by "until every preparation is complete?" This means the employment of every precaution which is available for the protection of the patient. The patient should be hospitalized as promptly and easily as possible, a compatible donor obtained and at hand, the delivery room set up for a transfusion and with means for controlling hemorrhage; the patient prepared and anesthetized. Then and *then only*, with the greatest care, should a vaginal examination be made. If the case is one of previa and the examination starts up fresh bleeding, the means are at hand for its control and if it becomes alarming, one will always be eternally grateful to have had both the donor and the transfusion set at hand. As soon as the diagnosis of previa has been made, preparations for delivery by cesarean section should be completed and the operation performed. If the patient requires it, a transfusion may be started before the operation, otherwise all preparations for transfusing are finished and the donor kept ready in the operating room. It is surprising how little bleeding accompanies a cesarean for placenta previa. By this operation one is able to deliver the patient of a living child, without the danger of hemorrhage and shock which accompanies delivery by the vaginal route and what is equally important, one is able with a donor at hand, to replace immediately, any loss of blood by transfusion. In August, 1923, it became the routine procedure on the Obstetric Division at the Woman's Hospital to have a compatible donor at hand and all preparations for a transfusion ready before examination or delivery in every case of placenta previa and since that time no patient has died of hemorrhage or shock. Since October 1, 1929, there have been 4 cases of placenta previa and all have been delivered by cesarean section without complications. Five out of the 69 women transfused in the

past four years had a placenta previa. All had some hemorrhage, varying from 500 to 1200 c.c. but all were transfused during labor or delivery and none died from hemorrhage or shock.

3. *Post-partum Hemorrhage.* In spite of the more potent oxytoxics which now can be readily given hypodermically, and in spite of more conservative handling of the uterus post partum there are still a certain number of uteri which do not contract well immediately after the birth of the baby or which fail to maintain a firm tone. This results in a more or less active bleeding, which at times may become alarming. Whatever may be the cause of this bleeding, the physician caring for an obstetric case, must have the assurance that he can meet this emergency with a reasonable hope of success. Prompt attention must be given the uterus and every effort made to insure a good tone which is well maintained. Extract of pituitary and some preparation of ergot should be given hypodermically. A firm holding of the uterus which brings the fundus out of the pelvis and forward towards the symphysis should be steadily continued. Massage should be avoided if possible. Packing of the uterus, cervix and vagina, may be necessary. Though this, however, is a debatable point, much may be said in its favor. It has undoubtedly saved many lives. The cervix should be inspected to ascertain if the bleeding comes from a laceration, and sutures taken if needed. These are all familiar steps which cannot be neglected. Fortunately, in addition to these blood transfusion has been employed for a number of years in this type of case with brilliant results. It restores to the circulation a more normal blood volume, which improves the muscle tone of the patient, and especially of her uterus. Better contraction results. Shock is overcome, and the patient's condition often changes in a few moments from one which was extremely serious to one which is definitely satisfactory. I would like to plead for an early use of blood transfusion in cases of post-

partum hemorrhage. This is a condition in which it is unwise to wait. The hope that the uterus will soon contract more satisfactorily, should not be indulged in. The more blood the patient loses the less tone her tissues have, and the vicious cycle is established. Twenty-five in this series of 69 cases were transfused because of post-partum bleeding.

4. *Post-partum Infection.* This condition fortunately is less and less often seen, but when it does occur the obstetrician wishes to employ every means at his disposal. In the fulminating case where the patient lives but a few days, she is so overwhelmed that but little can be done. However, when the infection is less virulent, repeated small transfusions materially help in increasing the patient's resistance and in establishing some immunity. Even a large number of transfusions can do the patient no harm, and seldom cause any reaction if the cross-typing is accurately done. There were 4 among the 69 women transfused who received this treatment because of a post-partum infection. Of these 4 cases one had a pelvic abscess, 1 a parametritis, 1 a suppurative mastitis, and 1 a septicemia. All had 2 transfusions post partum, varying from the tenth to the thirtieth day. All patients recovered. One must also remember that the greatest care should be taken of the donor in transfusing a patient who has an infection, as any break in the technique may transfer the infection to the blood stream of the donor.

In considering the protection of the obstetric patient, attention should not be centered on the mother exclusively and no thought be given to the baby. The expectant mother comes to the obstetrician with the confidence that she will have a normal, living child. Everything possible must be done to obtain this result for her. Prenatal care of the mother accomplishes much towards insuring a healthy child when labor begins. Skillful obstetrics goes far towards bringing the baby into the world in good condition. However, in spite of all care and skill there will always be a certain

number of babies who are subjected to strain either during late pregnancy or during labor and delivery. A procedure is now available which seems to offer help by giving these babies a better chance in their first few days of life. Under the supervision of Dr. Walter Lester Carr and Dr. Harold Mixsell it has been used for two years now, at the Woman's Hospital. This consists in the injection of from 20 to 30 c.c. of whole blood under the skin immediately after delivery, and at twelve hour intervals, the injection of an equal amount of saline or of serum as indicated. This is a simple procedure taking but a moment of time and is devoid of risk. The blood may be obtained from either parent, except in cases of toxemia, when it should always be taken from the father. Whole blood is used for the first injection in order to save the time necessary for obtaining blood serum. This use of a foreign blood and serum is supposed to shorten the clotting time of the baby's blood and thereby lessen the risk of cerebral hemorrhage; and the repeated injections of saline and serum supply fluids which are easily absorbed. Babies born of toxic mothers as well as those after a prolonged labor, or abnormal delivery, such as version, breech or difficult forceps, are suitable cases for these injections. During the past two years over 200 babies have received this treatment.

The results so far obtained justify the continuance of this procedure but no report is yet ready for publication. This procedure or a blood transfusion is also indicated in cases of hemorrhage in the newborn, and should be resorted to as soon as the baby shows any signs of bleeding, especially in vomitus or stools. There were two cases of hemorrhage in newborn in this series of transfusions. The babies each had but one transfusion and recovered. In the past four years these have been the only cases of hemorrhage in the newborn.

The practice of obstetrics today consists in much more than merely delivering a woman of her child. It requires the most careful supervision of every patient throughout her pregnancy in order that she and the baby may reach term in as favorable a condition as possible, and requires the employment of every precaution when complications arise in order to render the maximum amount of protection to both when most needed. It is only by careful watching for abnormal conditions and full preparedness in meeting them that we can give to these patients the protection to which they are entitled.

I wish to take this opportunity to express my appreciation of the work done by Dr. George Gordon Bemis and Dr. Nelson B. Sackett in tabulating and verifying many of these figures.



PROLAPSE OF RECTUM AND UTERUS

IN THE SAME PATIENT*

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THE object of this paper is to report a case of complete prolapse of the rectum, associated with prolapse of the uterus, and complete tear through the rectovaginal septum, which had grown progressively worse over a period of five years, and which, after nearly two years postoperative, presents a very satisfactory recovery.

Prolapse of the rectum is not an uncommon condition. The age of the patient, and the degree of prolapse, decide in a measure the general method of treatment. The multiplicity of operations, mechanical measures and procedures, lead one to believe that no one treatment is ideal and that each case of necessity must be studied as an individual problem, proving conclusively that much is yet to be done to relieve these patients.

Many theories have been advanced to explain the causative factors of these procedentiae, i.e., redundant mesorectum mesocolon, deep cul-de-sac predisposing to herniation of the bowel, relaxation of the lateral ligaments, stretching of the fascial layers, relaxation of the sphincters and levators. All or combinations of these probably explain the majority of cases. Exciting causes such as polyps, diarrhea, dysentery, whooping cough, chronic coughs, strictures (of the rectum), straining at stool, compelling children to sit at stool for periods of time, etc., undoubtedly all play a part.

Out of the many theories have grown several operations for the cure of prolapse of the rectum:

1. Plastic operations on the levator ani, pelvic fascia and sphincter ani, based on the theory that a deep cul-de-sac, relaxed lateral ligaments, relaxed levators and

sphincter ani are causative factors (Maes, Rives, McCann).

2. (a) Plastic operations on pelvic supports, and at the same time narrowing the external sphincter has been advocated by Lynch.

(b) Diffenbach, Duret and others have advocated in simple cases, a wedge-shaped excision to shorten and narrow the bowel.

3. Excision of the protruding gut has been advised by Mikulicz and also by Cunningham.

4. Obliteration of the cul-de-sac, combined with suspension of rectum and rectosigmoid has been described by many, especially Moschowitz.

5. Heald advocates simple rectopexy; fixation of rectum to sacrum and coccyx in children. This method of fixation of the rectum to sacrum and coccyx has been advocated and used by Tuttle and Mummery; they also advise shortening of the sphincter at the same time. Mummery attempts to obtain fixation by dissecting the rectum free from the sacrum, packing gauze in the space thus created and keeping it packed until granulation tissue formed and obliterated it.

6. In simple cases, injections of innumerable solutions, e.g., including 5 per cent quinine-urea-hydrochloride (Femel), pure alcohol (Boas, Nixon), 5 per cent phenol in Wesson oil (Spiesman), cresylic acid, glycerine and water (Montague), carbolic acid and hamamelis (Macewen), all with the idea of creating an inflammatory reaction, with resulting scar formation and thus fixation.

History: The patient was admitted to the gynecological service of the Albany Hospital on January 6, 1929.

* From the Gynecological Department of the Albany Hospital and Albany Medical College.
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She stated that about four and one-half years before admission, she was shocked, on learning of the sudden death of a daughter.

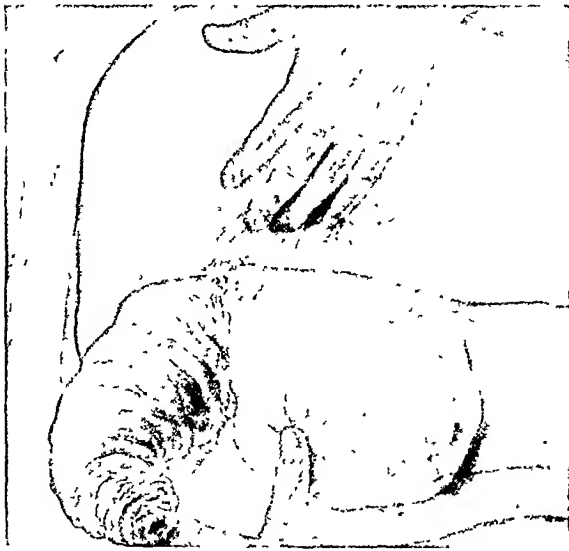


FIG. 1. Patient in left Sims' position showing prolapsed uterus (cervical os is visible) and prolapsed rectum.

It gradually prolapsed more and more, until at the time of her admission to the Hospital, when the bowel hung down from 12 to 15 in. For a year or more before this admission she stated she never knew when her bowels were going to move, she had no sensation or pain in the prolapsed gut, but at times a slight bloody discharge was present.

It seems remarkable that with a prolapse as extensive as this, that there were no ulcerations. The mucous membrane was of normal color and peristalsis could be seen in the prolapsed gut.

There was a second condition present, in degree, almost as bad as the first. She had a complete inversion of the vagina. In this sac, was the bladder, uterus, adenexa, and loops of small intestine. Questioned as to how long she had had the prolapse of the uterus, she stated she did not know it was present, thinking the whole mass was an exaggeration of what first appeared. When questioned more carefully, she stated that with her first baby thirty-two years ago she was badly torn; and with each



FIG. 2. Posterior view, showing prolapsed uterus; behind it, prolapsed rectum.

FIG. 3. Postero-lateral view, showing prolapsed uterus and rectum.

Following this, she did not have a bowel movement for over a week; a strong cathartic was finally effective. Since then she has been chronically constipated. About three months after the onset of the persistent constipation, she noticed "something came out" with a bowel movement, and stayed there. It hung out for about $1\frac{1}{2}$ in., and never went back. She paid little or no attention to the condition.

of six subsequent pregnancies, she had difficult labors. She had a sense of lack of support, but no urinary or fecal incontinence, prior to prolapse of rectum. Be this as it may, it seems doubtful.

The patient denied urinary difficulty: had no incontinence, frequency, nocturia or hematuria.

At the time of her coming to the Hospital, she was four years past the menopause. Menses

ceased abruptly and she has not seen any uterine bleeding since.

When she was admitted to the Hospital the

the cul-de-sac. Then the prolapse of the rectum was reduced by pulling it upwards. The cul-de-sac was then found to be on a level with the anal

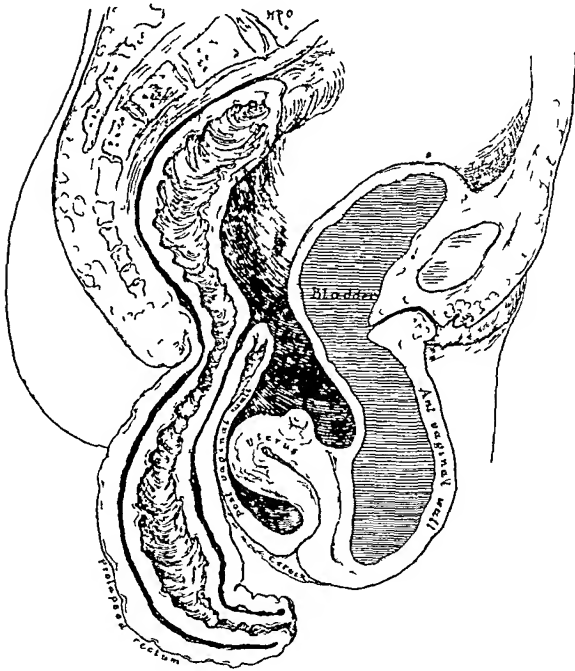


FIG. 4. Relative positions of rectum, uterus, bladder, etc.

protruding mass was supported by a hammock-like cloth fastened to an abdominal binder.

It might be of interest to note that this patient had worked daily from 4:00 A.M. until 9 A.M., scrubbing floors and sweeping in one of the State buildings of this city, and never lost a day's work over a number of years.

Accompanying illustrations demonstrate the conditions present, better than any verbal description. The large bowel hangs out about 14 in. The mass containing uterus, bladder, etc., is as large as a good-sized grape fruit. Patient also has a complete tear through the anal sphincter (Figs. 1, 2, 3 and 4).

Operation, First Stage: January 8, 1929. Reduction of the inverted vagina under ether anesthesia revealed the patient had a complete tear (through the sphincters). The uterus, somewhat enlarged, contained a myoma in the fundus about the size of a walnut.

Because of the combined prolapse of rectum and vagina and pelvic viscerae, a two-stage operation was decided upon and done by Dr. John A. Sampson.

After the opening of the abdomen, the uterus was drawn up into the incision, thus exposing



FIG. 5. One year, six months postoperative, showing final result of operation.

sphincter. Obliteration of the cul-de-sac was the greatest problem. The posterior surface of the vagina and anterior surface of rectum were denuded and the two surfaces sutured together by interrupted fine silk sutures, starting as low down as possible and proceeding upwards, thus obliterating the cul-de-sac. The sutures being carried around laterally on either side did this effectively.

The entire uterus was then brought into the abdominal incision and retroverted so as to lie horizontal in the incision. The peritoneum was sutured around the uterus at the level of the internal os and the body of the uterus was fixed to the under surface of fascia.

Second Stage: Two months after first stage:

Problem:

Complete perineal tear

Relaxed pelvic floor

Mild prolapse of rectum, about 4 in.
(Cervix high in vaginal vault)

A primary triangular denudation of the posterior vaginal wall was made and the peri-

neum laid wide open. The rectum was freed and pulled down. The superfluous 4 in. were amputated.

The levator ani muscles and torn ends of the sphincters were pulled across in front of the rectum, and sutured. The perineum was closed. The cut end of the gut was sutured to the anal margin as in a Whitehead operation for hemorrhoids. A new anus was thus formed which would just admit the little finger.

One Year Postoperative:

1. Uterus still fixed firmly in anterior abdominal wall.
2. Perineum in good condition.
3. No incontinence of urine.
4. Control of bowels practically fully recovered and gradually improving. If patient takes a purgative she may have some soiling of her clothing; otherwise control is good.
5. Works daily, gained weight, general condition good (Fig. 5).

One Year and Ten Months Postoperative:

Considered cured with no incontinence of feces even after cathartics.

General physical condition good.

SUMMARY

Reports of very extensive prolapse of the rectum are on record, but to find one

as extensive as the one we report is rare in this day when patients have learned the value of preventive medicine and the advantages of early surgery.

The most interesting feature of this case, is a combination of prolapsed rectum and uterus with complete tear through the anal sphincters. This combination is very rare. I was able to find references to only two articles, one, Simultaneous Rectal and Uterine Prolapse, by A. Caviglia,* and the other by Kosloff,† Simultaneous Rectal and Uterine Prolapse. Graves, Pemberton and Smith, report the study of 683 cases of procidentia of the uterus, 9 with fecal incontinence, but make no mention of associated rectal prolapse.

With a complete perineal tear, through the sphincters, straining, etc., at stool is not necessary; on the contrary, the victim is incontinent. Thus one of the principal etiological factors of procidentia is removed, and to have a rectal prolapse in combination with a tear through the sphincters is not a common occurrence.

* *Bol. Soc. de obst. y ginec.*, 7: 122, 1928.

† *Omsky M. J.*, 2: 47, 1927.

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PYELOGRAPHIC EVIDENCE OF HORSESHOE KIDNEY

REPORT OF A CASE IN A GIRL THIRTEEN YEARS OF AGE*

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RECENT studies, observations and reports by various urologic investigators concerning persistent pyuria in infants and children have proved conclusively that congenital changes in the genitourinary organs may be the predisposing factors and play an important part in the chronicity of this affection. As is well known, persistent pyuria in children may be due to a variety of causes aside from true urological factors, and proper therapy depends entirely upon eradication of any existing focus of infection. It is believed by many that the predominance of the infection in females is due to an ascending infection from the urethra and bladder. A bacillus of the colon type is generally the infective organism, but it may also be due to other organisms such as the staphylococcus, gonococcus, etc. The condition may be mild or a pyelonephritis may be present and associated with severe complications such as lobar and bronchopneumonia, otitis media, or septicemia. It is true that many cases of simple pyelitis will respond to internal medication and removal of contributory foci of infection, but congenital and obstructive urogenital factors may be present which demand a complete urologic investigation. Lowsley and Butterfield, in their study of a series of 100 cases of urological conditions found that there were 29 instances of congenital abnormalities, of which 13 were serious enough to cause infection in these organs. In a series of 4903 necropsies in infants, Bugbee and Wollstein found that 117, or 2.3 per cent showed congenital changes that could be responsible for the infection. Hyman in 1917, reported a series of 38 cases from the children's surgical ward at Mt. Sinai Hospital, and in 1926, 150

additional cases of diseases of the urinary tract in children. Of these, 94 cases showed renal changes, 48 vesical, and the remainder ureteral and urethral changes. H. O. Mertz in a series of 49 cases, in 20 or 40 per cent, congenital changes in the urinary organs were found present. It is surprising that some cases of the congenital variety give rise to very few symptoms; however, if obstructive factors are present, serious damage may result and the prognosis becomes extremely grave.

Among the various anomalies of the genitourinary tract, horseshoe kidney is one that plays an important rôle in persistent pyuria, because it is often the seat of disease, such as stone, tuberculosis, etc. Carlier and Gerard, (quoting J. A. C. Colston and W. W. Scott) in a study of 68,989 autopsies, found 80 horseshoe kidneys, a ratio of 1 to 862. Kuster found 1 case in 1100 and Naumann, in a similar series of cases, found a ratio of 1 to 600, and Davidsohn 1 to 1000.

The preoperative diagnosis is not easily made; however, there are certain factors, such as the appearance of the pyelogram in conjunction with certain subjective and objective signs, which make the diagnosis fairly accurate. Correct diagnoses verified by operation, have been made by Rovsing, Israel, Judd, Brasch, Scholl, Löffler, Eisendrath, and others. The appearance of the pyelogram, which is of great importance, will show the renal shadows to be lower in position than the normal ones, and closer to the vertebral column. In contrast to the rest of the shadows, the lower pole will be indistinct, and in a few cases, the faint outline of the isthmus itself can be seen extending across the vertebral column. As a general rule, one or both of the ureters are

* Presented before the Fulton County Medical Society, February 5, 1931.

shortened. The pelvis of the kidney will lie close to the midline, and the calyces will be turned downward or toward the vertebral

poles are fused, and at a higher level when the upper poles are fused.

Because of the interesting facts brought

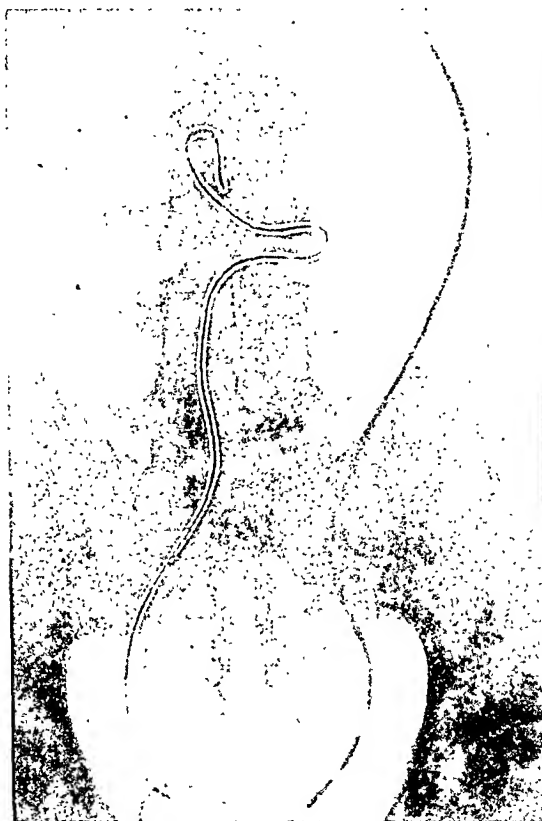


FIG. 1 (Dr. Eisendrath's case). Location of opaque catheters in case of horseshoe kidney. Note how catheter in right ureter curves inward at sacroiliac joint and runs upward along middle of anterior aspect of lumbar vertebrae to end opposite interspace between second and third.

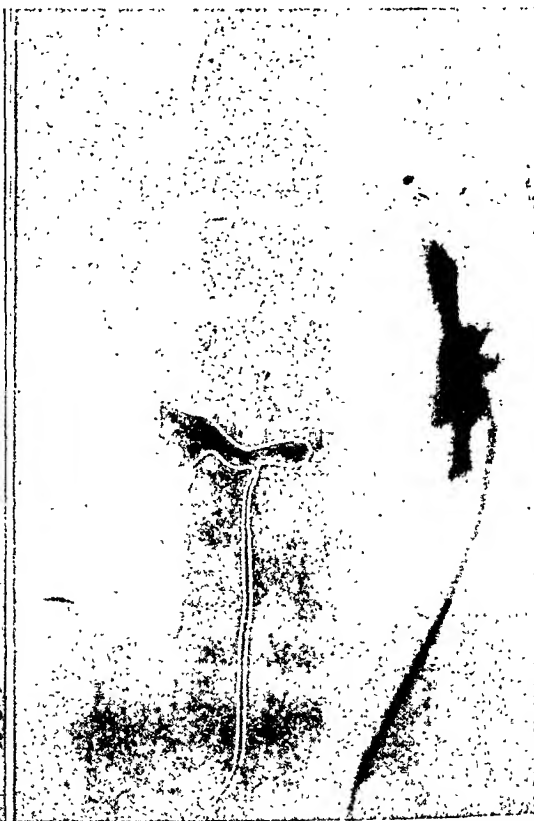


FIG. 2. Pyelograms (bilateral) of same case illustrated in Fig. 1. Note location of pelvis of right half over body of third lumbar vertebra. Also observe wide distance of pelvis of left half (with its mesially directed calyces) from the vertebrae.

column. Stereoscopic pyelograms are of value in arriving at a diagnosis. Of importance, however, is the fact that not all horseshoe kidneys are in the same plane, as recently illustrated in a case of Eisendrath's. This can be explained in the fact that the isthmus may vary in size, shape, and character of tissue. It may consist of a membranous cord, a fibrous band, or the bridge may be broad and consist of secreting tissue. The bridge may be situated either in front or behind the aorta and vena cava, or may even lie between the vessels. It generally lies at the level of the fourth and fifth lumbar vertebrae when the lower

out in Eisendrath's case, permit me to briefly review some of the findings which corroborated his diagnosis of horseshoe kidney. His patient, a male, aged twenty, was admitted to the Michael Reese Hospital on June 28, 1926, presenting symptoms of left ureteral colic and a recent hematuria. He had previously had three attacks. A No. 5 catheter encountered an obstruction in the lumbar region of the left ureter. However, a No. 4 catheter entered the renal pelvis without difficulty. A flat film, the opaque catheters having been inserted, showed a shadow extending on both sides of the upper four lumbar

vertebrae. The shadow on the right side extended a short distance beyond the spine, and on the left side, the outer border was

curved sharply inward. A pyelogram (Fig. 2) showed a small transversely placed pelvis lying across the body of the third

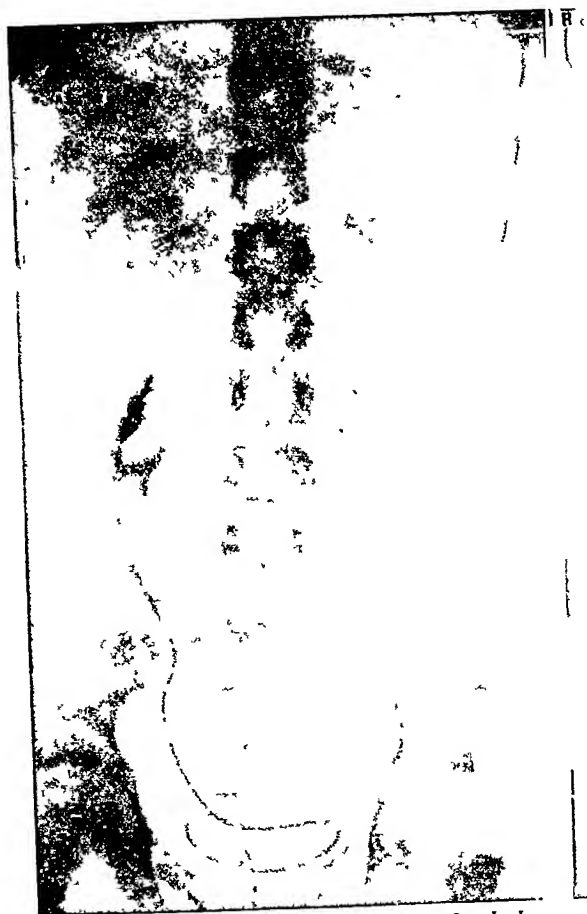


FIG. 3 (Author's case). Pyelogram of right kidney. Note that right catheter curves outward after crossing the sacroiliac joint and stops short, just above superior border of ileum. Catheter enters lower calyx of kidney which points mesially toward spinal column. Upper calyx points posteriorly and mesially. Renal shadow which is located close to spine, extends from upper border of third lumbar vertebra to about middle of fifth lumbar. Part of renal shadow appears to overlap margins of bodies of vertebrae.

on a line with the tip of the twelfth rib. The right catheter (Fig. 1) passed sharply inwards at the level of the corresponding sacroiliac joint, then directly upwards close to the median line of the spine, until it reached the third lumbar vertebra, at this point making a sharp turn to the right. The left catheter curved outward from the corresponding sacroiliac joint, lying well away from the spine until it reached the level of the first lumbar vertebra and there



FIG. 4. Pyelogram of left kidney (same case as Fig. 3). Note catheter crossing sacroiliac junction, taking outward curve. It then extends close to margins of lumbar vertebrae, and passes directly outward to enter lower calyx. Calyces point posteriorly, and renal shadow, which is indefinite, shows density close to spinal column.

lumbar vertebra, and extending slightly beyond the right border of the spine. The ureter entered the middle of the lower border of the transverse renal pelvis. The pyelogram on the left side showed a much larger pelvis, the upper calyx extending to the twelfth rib, the lower calyx to the upper border of the fourth lumbar vertebrae. Diagnosis of a calculus of light density in the pelvis of the left half of an L-shaped kidney and also the possibility of a horseshoe kidney, were confirmed at operation on June 30, 1926. The isthmus was 5 cm. wide and located at a higher

level than the usual operative cases. The pelvis and major calyces were almost completely extrarenal. The ureter and pelvis were very much thickened. No calculus was found; however, a stricture of the juxtavesical portion of the ureter was found through retrograde catheterization. The patient made an uneventful recovery.

A similar case was also observed at autopsy by Garree and Ehrhardt, and also a case by Henry S. Browne. In the latter's case, a perinephritic abscess developed at the left portion of the horseshoe kidney, rather an unusual finding. The pyelogram showed, on the right side, the very low position of kidney pelvis, lying close to the spinal column with mesially directed calyces. On the left side, the upper calyx extended as high as the eleventh rib, the lower calyx to the middle of the second lumbar vertebra, and not in close proximity to the spinal column.

As to the blood supply, it must be remembered that the anatomical location of these vessels may be entirely changed. The aorta gives off the renal arteries at a lower level, the latter passing obliquely downwards to the kidneys and frequently enter the kidneys from behind. Before entering the kidneys, the arteries are usually multiple, or if single, branch before entering. Accessory arteries supplying the isthmus may be present. A knowledge of these findings will place the surgeon on guard in operations on horseshoe kidneys, chief of which is a dull indefinite pain described by Rovsing, and located below the epigastrium, more marked when the patient is in the erect position. Rovsing believes that the pain is due to fixation of the isthmus while the kidneys are movable. Of course pathological conditions present in the organ, such as stone, pyonephrosis, etc., will give rise to symptoms characteristic of these pathological factors.

REPORT OF CASE

E. Mc., female, aged thirteen, one brother living and well, mother and father living and

well, was first seen at the Grady Hospital, Urological Service of Dr. W. A. Upchurch, September 25, 1930. Her chief complaint was pain in the epigastrium and lower abdomen of two years' duration. The pain was of a dull, aching character, and seemed occasionally to radiate toward the back, especially in the lumbar region. With the exception of having had the usual diseases of childhood, the past history was otherwise negative. She complained of frequency of urination during the day and occasionally complained of a nocturia. There had never been any blood in her specimens. The pain was not constant, but would last an hour or so and then disappear. She would at times be free from pain for two months. She also stated that she did not have any pain when lying down.

Physical examination was negative except for the fact that the patient appeared small and apparently undeveloped as compared with a normal girl of her age. There must have been present an accompanying glandular disturbance for the reasons that she had never menstruated, there was no presence of pubic hair, and the genitalia appeared undeveloped. Palpation of the abdomen revealed a firm rounded mass, just to the right and a little below the umbilicus, extending slightly across the midline, and having the characteristics of a renal outline.

After preparation, cystoscopy was performed, the instrument entering the bladder without difficulty. The bladder mucous membrane appeared slightly congested, but there was no evidence of any pathological condition present. The ureteral orifices appeared close together and very small, showing a slight surrounding redness. No. 4 catheters were passed to both renal pelves without encountering any obstruction. The left catheter, however, seemed to extend much further than the right, before reaching the renal pelvis. A specimen collected from the right kidney was hazy and showed a moderate number of pus cells. The specimen from the left kidney showed a moderate number of pus cells and an occasional red blood cell. Phthalein injected intravenously appeared in three and one-half minutes from the right kidney and six minutes from the left side. The phthalein quantitative estimation showed that the output was normal from the right kidney but there was a slight diminution of the dye output from the left side.

The x-ray findings showed a very interesting condition. A plain roentgenogram did not reveal any calculi, but showed the right renal shadow situated low and close to the spinal column. The left shadow was indefinite. A pyelogram made of the right kidney and ureter (Fig. 3) showed the following: the right catheter curved outward after crossing the sacroiliac joint and stopped short, just above the superior border of the ileum. The catheter entered the lower calyx of the kidney which pointed inwardly toward the spinal column. The upper calyx appeared to point posteriorly and mesially. An outline of the renal shadow showed that it was located close to the spine extending from the upper border of the third lumbar vertebra to about the middle of the fifth lumbar. Part of the renal shadow appeared to overlap the margins of the bodies of the vertebrae. Because of the abnormal finding, I was anxious to know the appearance of the pyelogram of the corresponding kidney, and this was carried out a week later. The pyelogram of the opposite side (Fig. 4) showed the catheter crossing the sacroiliac junction, taking an outward curve which was more pronounced than the characteristic curve seen in the usual cases. It extended close to the margin of the lumbar vertebrae, and then passed directly outward to enter the lower calyx. The calyces pointed posteriorly, and the renal shadow, which was indefinite, showed a density close to the spinal column. These pyelographic findings are very characteristic of the presence of a horseshoe kidney, and as a general rule, are verified by operation.

COMMENT

As has already been explained, correct preoperative diagnosis of horseshoe kidney is not a simple matter, and it is only on the operating table or in the autopsy room, that we are able to confirm our diagnosis. However, there are certain

clinical facts in addition to our pyelographic findings, which may justify one in arriving at a tentative diagnosis, and should any surgical emergency arise in a patient suspected of having this congenital anomaly, the surgeon should be on guard, and proper measures should be carried out accordingly. The anomalous rotation of the renal pelvis, the unusual location of the calyces, the finding of the renal shadow lying close to the spinal column, the abnormal insertion and shortening of the ureter, the visibility of the presence of an isthmus, all point to a definite renal abnormality, and that abnormality suggests a horseshoe kidney. Clinically, the presence of Rovsing's sign may be of great value. One must remember also that horseshoe kidney is more liable to infection than a normal kidney, and may be subject to various diseases such as stone, tuberculosis, pyonephrosis, etc. Therefore, one must be on guard for these symptoms and treat the condition accordingly.

In conclusion, may I emphasize the fact that in congenital anomaly of the kidney, especially of the horseshoe variety, stasis and infection are usually present and proper therapy depends upon carrying out ureteral dilatation and pelvic lavage in order to alleviate the patient's symptoms.

To date, three cystoscopies on this patient have been performed. The treatments consisted of gradual ureteral dilatations followed by the injection of a few cubic centimeters of 5 per cent argyrol into the renal pelvis. As a result, her condition has improved considerably. This case is of clinical importance because it demonstrates the necessity of a thorough urologic investigation in individuals with a persistent pyuria.

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[For Remainder of References see p. 92]

URETER CATHETER DRAINAGE IN URETEROTOMY*

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SINCE the ureter catheter is one of the tools of his trade the urologist is usually fully appreciative of the important part it plays in ureter and kidney surgery. Many surgeons are less aware of its value and frequently fail to take advantage of its use.

The presence of a catheter in the ureter is of value in numerous ways. The ureter is more easily identified when it contains a catheter. A stone in the ureter is usually held in a fixed position by the catheter and migration is prevented.

After ureterotomy the catheter serves an important purpose. We believe it is of little importance whether the ureterotomy wound is sutured or not. The catheter establishes the urinary channel and the likelihood of fistula or extravasation occurring is minimized with the diversion of the stream from the kidney pelvis through the catheter. The tendency of stricture formation is lessened and obliteration is prevented. Irrigation of an infected pelvis can be carried out when indicated. The drainage of a pelvis may also be an important factor in preventing anuria and infection.

CASE REPORT

The following case report illustrates in a near tragic way what the consequences may be when the precaution of inserting the indwelling catheter is not carried out:

J. E. W., a white man, thirty-four years old, reported on Aug. 26, 1929, because of attacks of sharp colicky pain in the right kidney area. The pain radiated anteriorly to the bladder region and to the right testicle. The attacks of pain occurred at varying intervals and lasted from two to forty-eight hours. At times a prolonged soreness in the right flank and in the right side of his abdomen corresponding to the course of the ureter

followed the pain. The rest of the history was irrelevant. Physical examination showed a well developed man with no abnormalities. His temperature and pulse rate were normal. The urine showed a trace of albumin, a few erythrocytes and an occasional leucocyte. Cystoscopy, ureter catheterization and functional tests demonstrated nothing abnormal. A small stone in the pelvis of the right kidney was demonstrated in the roentgenograms. During the following eight months a series of monthly roentgenograms showed the stone descending to the middle part of the right ureter.

On July 10, 1930, he had several attacks of pain of greater severity and of longer duration than heretofore, and at this time he also complained of pain on defecation. The roentgenogram now showed that the calculus had descended to the pelvic portion of the right ureter. A cystoscopic examination showed an edematous right ureteral orifice which readily admitted a No. 5 F. catheter. An obstruction was encountered about 5 cm. from the orifice. When the catheter was manipulated beyond this obstruction 4 c.c. of sterile albolene were introduced, and the catheter was withdrawn. In addition, the right ureteral orifice was enlarged by an intravesical incision with the Bumpus ureteral scissors to facilitate the passage of the calculus. This procedure failed to bring about passage of the stone. Severe colic continued for four days.

Cystotomy and ureterotomy under ethylene anesthesia were performed on July 15, 1930. It was impossible to express the stone into the bladder from its impaction in the ureter about 2 cm. from the orifice. The calculus could not be milked upward to a more accessible location. Consequently a longitudinal incision directly over the impaction was made, and the stone removed. It measured 2 cm. in length by 1 cm. in thickness and was very rough and jagged. Our usual procedure of inserting an indwelling ureteral catheter was impossible. No type of catheter or probe could be introduced from the bladder into the ureteral

* Presented at the meeting of the Wisconsin Urological Society, Madison, Wis., April 11, 1931.

orifice more than 2 cm. The bladder was then closed around a No. 30 F. Pezzer catheter. Drainage from the ureteral bed was obtained

at the time of operation prevented the passage of the No. 7, 6, 5 and 4 French catheters. Finally a No. 3 catheter was passed up the



FIG. 1A



FIG. 1B

FIG. 1. A. Calculus in upper right ureter obstructing ureter catheter. B. Calculus included in filling of upper ureter.

with a rubber dam drain brought out through the suprapubic wound. This drain was removed after twenty-four hours, and the Pezzer catheter after six days.

On the second postoperative day he complained of severe pain in the right lower quadrant of the abdomen. He was restless and irrational at times. The pulse was thready and ranged between 120 to 140 per minute in rate. Abdominal examination disclosed tenderness and rigidity in the right iliac region. On the third postoperative day there developed a complete suppression of urine in spite of free intake of fluids by mouth. An infusion of 500 c.c. of 5 per cent dextrose solution in normal saline was of no avail. The patient was transfused with 600 c.c. of whole blood. A free diuresis followed immediately. The suprapubic dressings were saturated when the patient left the operating room. The abdominal pain, tenderness and temperature persisted until the sixth postoperative day when cystoscopy was done. The obstruction encountered

right ureter. This catheter was left in place for twenty-four hours and a free flow of urine from the right kidney was maintained. Two kidney lavages with 0.5 per cent mercuriochrome were done during this period. A ureteropyelogram done at the end of twenty-four hours revealed extravasation of the solution of sodium iodide about the ureter at the site of obstruction. After another twenty-four hours the roentgenogram revealed the complete disappearance of the extravasated iodide. The symptoms gradually disappeared, and henceforth his convalescence was uninterrupted.

On Aug. 22, 1930, six weeks after operation a No. 5 catheter could be introduced into the right ureter for only 2 cm. A No. 5 catheter passed easily 30 cm. up the left ureter. The urine from the right side showed many leucocytes and a few red blood cells, that from the left side was normal. One cubic centimeter of phenosulphonthalein given intravenously appeared in four minutes in the right kidney urine with a total excretion of 4 per cent in



FIG. 2A



FIG. 2B

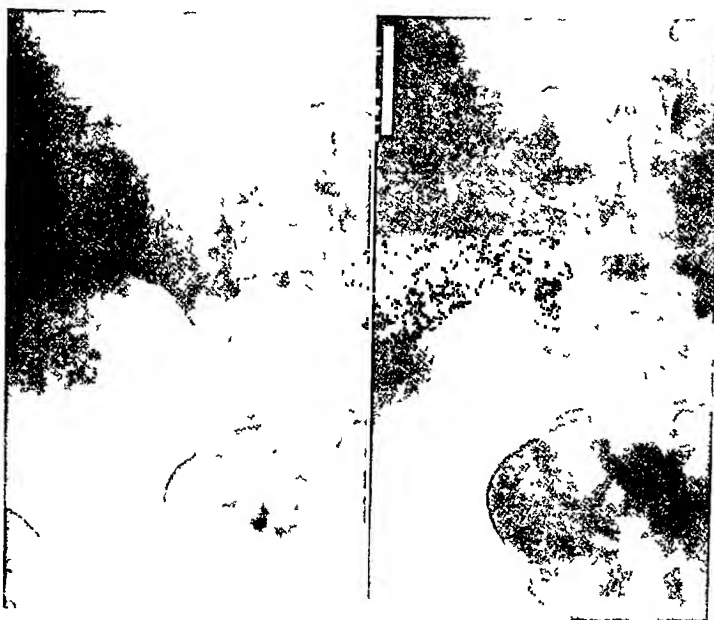


FIG. 2C



FIG. 2D

FIG. 2. Descent of calculus during nine months from October, 1929 to July, 1930. A. Shadow seen at level of third lumbar vertebra. B. Shadow at level of lower margin of fourth lumbar vertebra. C. Shadow in pelvis opposite mid-sacrum. D. Shadow at lower margin of sacrum or about 2 cm. from ureteral opening in bladder.

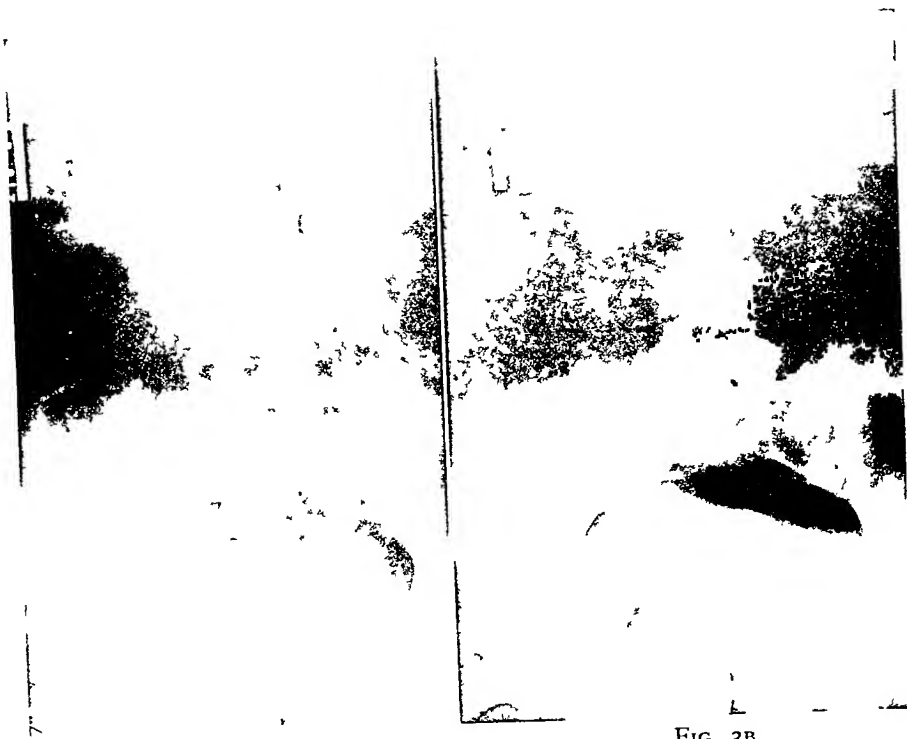


FIG 3A

FIG 3B



FIG. 3C

FIG. 3. Postoperative roentgenograms A Pyelogram obtained after gentle injection of 4 c.c. of 15 per cent sodium iodide, but no ureteral filling occurred. B A few moments later an added 2 c.c. of sodium iodide solution were injected into ureter, and roentgenogram showed extravasation of iodide into pelvic tissue. C. Roentgenogram made twenty-four hours later, demonstrating complete absorption of iodide.

10 c.c. of urine in fifteen minutes. On the left side the dye appeared in three minutes with a total excretion of 15 per cent in 24 c.c. of urine. On Sept. 20, 1930, ten weeks after operation a No. 6 catheter was introduced in the right ureter experiencing some difficulty through the first 2 cm. A normal function was now present. The phenosulphonphthalein appeared in five minutes and 15.5 per cent was excreted in 12 c.c. of urine during the fifteen minute test. The urine was normal.

DISCUSSION

Following ureterolithotomy our attempts to pass a ureteral catheter at operation were unsuccessful. The rubber drain was removed from the ureteral bed twenty-four hours following operation. This early removal was carried out with the hope that the urine would make its way through the lower ureter promptly instead of through the fistula thus obviating ureteral obliteration. The urine continued to extravasate and the fistulous tract closed with

the development of symptoms of sepsis and urinary absorption and anuria. Blood transfusion overcame the anuria in a phenomenal way. The symptoms of sepsis and urinary absorption were miraculously relieved by the passage of a ureteral catheter.

CONCLUSIONS

The preceding case record demonstrates the consequences of omitting ureter catheter drainage. The indwelling catheter has a distinct place in ureteral surgery because it insures kidney drainage, eliminates fistula and urinary extravasation by diverting the stream, promotes prompt healing and prevents stricture formation. It may also act as a prophylaxis against suppression of urine.

Our thanks are due Mr. Leo Massopust, Marquette University School of Medicine, for the illustrations.



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CONJUGAL INFECTION OF BACILLUS COLI

ASSOCIATED WITH GANGRENE OF THE TESTICLE*

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MY purpose in presenting this report is:

1. Because gangrene of the testicle, due to colon bacillus, is very rare.
2. Because epididymitis, due to the same organism, is uncommon.
3. Because conjugal infection with *B. coli* has not been reported before in the literature, although it probably has occurred.
4. That a diarrhea though intense should produce such a virulent pyelitis, cystitis and appendicitis in the host, followed by so destructive a lesion of the epididymis and testicle of the husband.
5. That a testicle seemingly impotent because of a variocoele operation, functioned normally after the loss of the other.
6. To present a brief review of the available literature on epididymitis and orchitis due to this organism.

Non-specific epididymitis and orchitis has always been interesting subjects because of its generally accepted uncommon occurrence with the possible exception of that following mumps and tuberculosis. Various etiological factors have been recorded, as mumps, influenza, smallpox, typhoid fever, malaria, sepsis, gout, tuberculosis, serum sickness, chickenpox, torsion, trauma, typhoid and paratyphoid vaccine, and sporotrichosis. Less has been said of that caused by the colon bacillus.

In the available literature only 26 cases of colon bacillus have been reported, in 11 of which the testicle was not involved; in 6 it was swollen but subsided without operation; in 3 it was abscessed but cleared up after incision, whereas in 6 it was abscessed and completely destroyed.

Keyes speaks of gangrene of the testicle but no reports have been found.

The case I wish to present is that of Mrs. K. W., twenty-eight years of age, who, with several other nurses, was stricken with an acute diarrhea caused by some food. One week later she complained of severe bladder irritation, frequency, burning, dysuria, pyuria and intense pain in the kidney region, of fever, chills, followed in two days by pain over McBurney's point. She had a temperature of 103°F., signs of definite distress, pain on palpation and percussion over both kidneys, bladder, and appendix regions. There was a slight leucorrhea not complained of. Smears showed a gram-negative bacillus. The uterus and adnexa were normal. Pressure against the bladder on vaginal examination produced pain. White blood corpuscles, 16,400. Urine contained pus and colon bacilli.

On April 25, 1928, three days after onset of bladder trouble, cystoscopic examination was performed and x-rays were taken. The bladder mucosa was much inflamed. Specimens of urine from kidneys and bladder showed pus and colon bacilli. There were no stones or anatomical abnormalities. Bladder irrigations, instillations, douches and pelvic lavages were given alone with other usual drugs with considerable benefit but no cure was effected before appendectomy was performed May 19, 1928, because of increasing pain and tenderness over McBurney's point, associated with rising temperature. Gastrointestinal x-rays were taken to confirm this since a pyelitis was present. The appendix was moderately congested at operation and the localized pain disappeared postoperatively. The bladder and kidneys became free of bacteria October 19, 1928.

No intercourse occurred from the onset until July, 1928. Shortly afterwards her husband complained of slight frequency of micturition. Later, after a strain while playing baseball, the right epididymis became swollen, reddened, tender, and sore. Some urethral

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discharge developed with marked frequency every one-half to one hour and dysuria. The right vas and seminal vesicle were enlarged and tender. Only a gram-negative bacillus was found in smears. Instead of the swelling subsiding in the usual period, it increased, and the temperature rose to 103.5°F. There developed a definite fluctuation, so on August 25, 1928, the epididymis was incised and drained. At this time the tunica albuginea was normal in appearance though the testicle was somewhat enlarged. Pure culture of colon bacillus was grown. Several days later the testicle became gangrenous and gradually sloughed out till only a small stump was left. The urethral discharge became sterile in ten weeks.

There was never any history of specific disease, but a herniorrhaphy and varicocele operation had been performed on the left side several years before.

During the several years of married life, no attempts had been made to prevent conception, yet no pregnancies had resulted. However, within a year after this unfortunate experience she became pregnant, and delivered a healthy child on March 31, 1930. This pregnancy caused no recurrence of the pyelitis or cystitis, but raises the question and leads one to believe that the infection had apparently activated spermatogenesis of a seemingly unproductive and abnormal testicle.



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*Continued on p. 70.

FUNCTIONAL POSITION FROM THE ORTHOPEDIC STANDPOINT*

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IN the care of patients it is most important to see that function is the primary consideration. Cosmetic results are secondary. Of course, when possible both should be sought.

Let me begin with the feet. Every orthopedic clinic has many weak and flat feet to treat. Many of these are secondary to some medical or surgical condition.

How often does a surgeon or internist consider the feet of his patients when they are convalescing from some long drawn out medical condition or operation? And in many cases it need not be a drawn out illness. In our histories we often get the following statements: "My feet never gave me any trouble until I got up from my last confinement . . . until after I got out of bed following the removal of my appendix . . . until I had pneumonia."

If you will draw upon your imagination a little you will agree with me that walking is rolling. We are provided with two spokes, the lower extremities and two sections of the wheel circumference, the two feet. To have a good wheel for rolling it is necessary that each sector of the circumference be at a right angle to the radius.

If this analogy be remembered fewer feet will be permitted to go into equinus, the mechanical basis for weak and flat feet. If medical as well as surgical cases are properly attended so that patients are able to dorsiflex their feet to at least a right angle, fewer cases would require foot attention and few would have sequelae.

Traumatic cases, such as fractures of tibia, fibula or even higher, of the femur and hip joint, are often put in splints and casts, permitting the foot to be in equinus. Many such traumatic flat feet continue to disable the patient long after the primary injury has healed and the patient discharged as cured.

When ankle joints are to be immobilized, the surgeon should see to it that the foot is at a right angle to the tibia and in neutral position as to varus or valgus. There are exceptions of course, when the foot cannot be placed that way to hold the fragments in position. If, however, the surgeon keep in mind the possible foot condition and not dispose of the case until the foot functions well, the patient will do better. It is often better to do a subcutaneous tenotomy of the tendon Achilles at the time and hold the foot in a functional position immediately rather than leave it to some subsequent treatment.

In poliomyelitis cases arthrodesis in equinus is recommended provided that the extremity is shorter than the other limb. Such routine fixation however should be guarded. Only recently a case of recurvatum at the knee was referred to me that was secondary to such treatment. The extremity was $1\frac{1}{4}$ in. longer than the other part, an extreme case and yet overlooked.

The functional position at the knee is, in extension, most comfortable with 5° and not more than 10° flexion. I have seen many a case in which the knee was held in flexion or permitted to go into flexion. It is then not very long before the complications of equinus at the foot and flexion deformity at the hip resulting from it, complicate matters.

Many a poliomyelitis case of flail knee could go without a brace if the flexion deformity did not exist at the knee. A slight recurvatum position in such cases is preferable.

The functional position at the hip is abduction and if one attempts bony ankylosis at the hip it is better to slightly rotate the extremity outward. One must remember that most patients do not have valets or maids to aid them in dressing.

* Read before The Clinical Conference of the Community Hospital, New York City, March 10, 1931.

When the hip is in abduction and the foot pointing forward, the patient cannot put on an oxford or shoe. Flexion of knee takes the foot out of reach of the patient. However, if the limb is rotated outward, the flexion of the knee takes the foot obliquely posteriorly to the opposite side within the reach of the patient's hands.

If one studies the cases where the rotation is not taken care of, one discovers that Nature attempts to obtain it at the price of a loose knee joint. It is better to have a slight flat foot alone than a combination of laxity of the knee and the flat foot as well.

Flexion adduction deformities at the hip are seen when abduction is not maintained. With flexion adduction, there is almost sure to follow the awkward gait, lordosis, flexion at the knee and equinus at the foot. Practically every condition at the hip should be treated in some degree of abduction.

The spine curves should be maintained in normal position as much as possible. A spine although ankylosed but in normal line does not interfere very much with the patient's activities. Most patients obtain increased flexion at the hips which makes up for the loss of flexion in the spine.

I have seen a number of cases in which the cervical spine was permitted to go into flexion and ankylose so that the patient's mentum was on the sternum with complete loss of function to the lower jaw. Malnutrition usually follows and there is a miserable being both to himself and to those about him. The use of a brace such as a Taylor spinal with a neck extension to hold the head in extension will often obviate such conditions.

Much can be done with the shoulder when put up in a functional position. In cases of tuberculosis, fracture of head or neck and flail paralytic humeroscapular joints, the salute position of the arm gives an excellent functional position. With complete ankylosis at the humeroscapular joint the upper extremity will function very well through use and muscle training of the scapular thoracic muscles.

A poliomyelitis case with flail shoulder joints usually has a functioning scapular. And if the elbow and hand function well, arthrodesis of the humeroscapular joint in the salute position will improve the function of the upper extremity many times and often make the patient independent of any outside assistance.

A girl eighteen years of age had poliomyelitis in infancy, resulting in flail shoulder joints. The upper extremities hung at her sides. She could not feed or dress herself. On examination the right elbow, forearm and hand were seen to function very well, but without the shoulder joint function, the extremity was of very little use to her. The left elbow was flail; there was about 50 per cent function in the left hand.

Four years ago an arthrodesis of the right humeroscapular joint was performed. The salute position was maintained. Within six months from the time of operation the young woman became independent of outside assistance to feed or dress herself.

The elbow should be in flexion of about 80° and the forearm in semipronation. In most activities we require our elbow in flexion. With functional wrist and shoulder the patient can do practically everything.

The wrist is an important joint. Many a hand is useless long after the traumatic condition is healed. If one will try gripping with the wrist in various positions from marked flexion to extreme dorsiflexion, it will be noticed that the greatest power is obtained when the metacarpal bones are at about 135° to the forearm. The best way to remember the position is to put one's own forearm on the table and make a fist. The angle obtained is the one to be used, usually 135°.

I have found that after-treatment is much easier if we begin with a functional position. It is usually also a neutral position, so that one set of muscles is not overstretched. Once the patient can begin doing something and have his mind diverted, much can be obtained in shortening the convalescent period. Early return to normal work will further aid the return of function of the part.

INCISION FOR EXPOSURE OF THE ELBOW JOINT*

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EXPOSURE of the elbow joint may be accomplished by several well-known and classical incisions which, however, are mutilating to the articulation. In most operations for this purpose the joint is approached from the

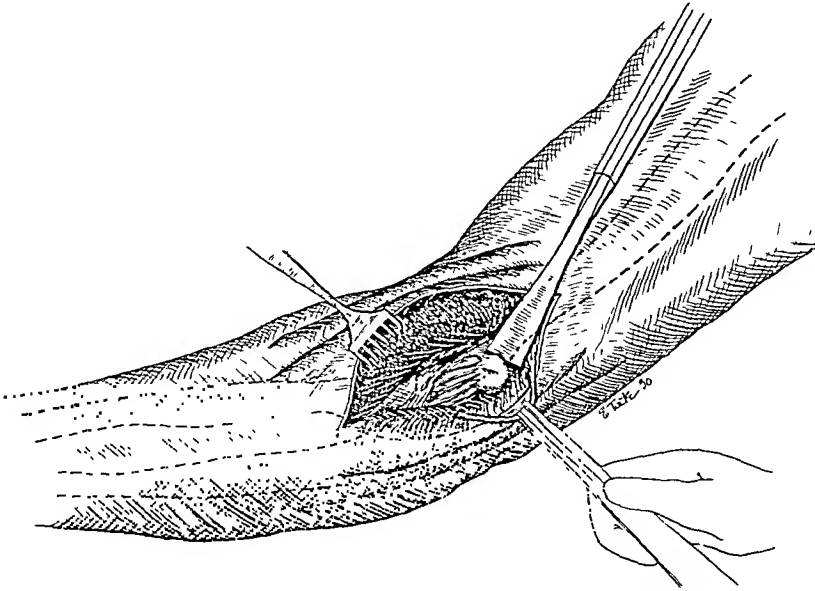


FIG. 1. An incision, 4 in. long, is made on inner aspect of elbow. Ulnar nerve is retracted and internal epicondyle divided with a chisel.

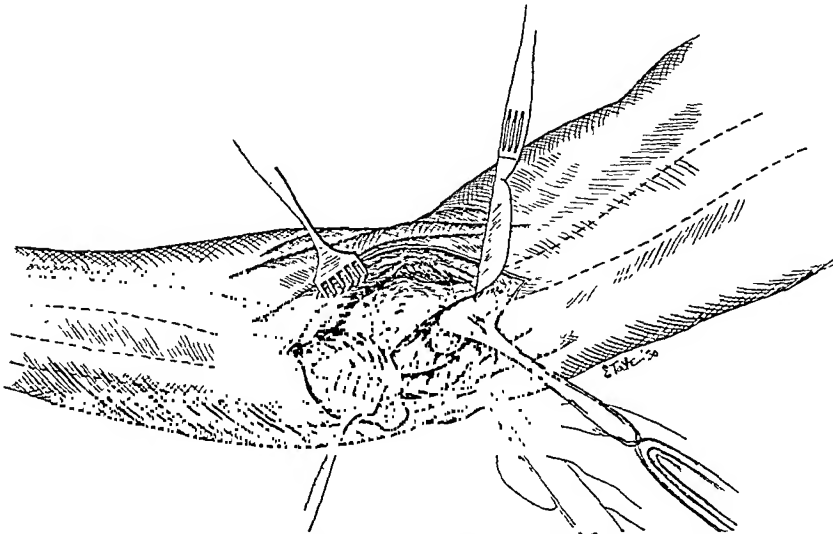


FIG. 2. Epicondyle with its muscular attachment is reflected downward, capsule of joint is incised and periosteum stripped from anterior and posterior surfaces of humerus.

ever, necessitate extensive stripping of the lateral aspect and only an imperfect exposure of the interior of the joint is

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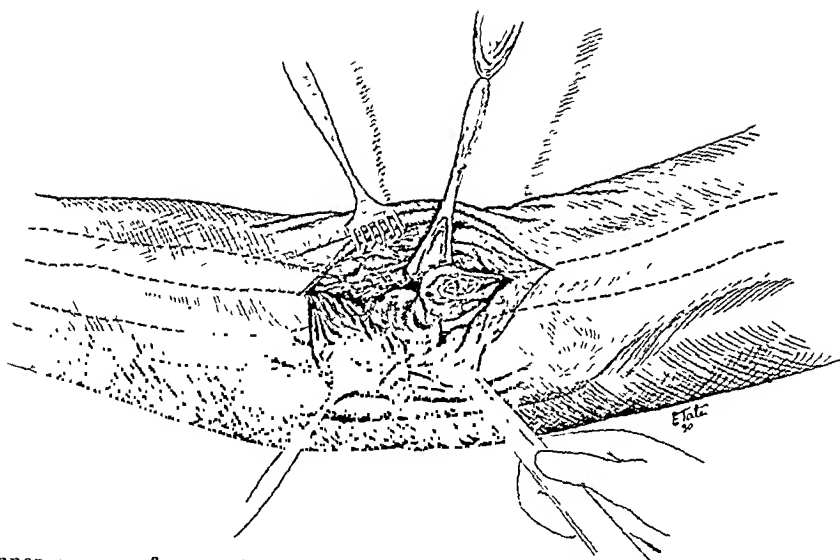


FIG. 3. Inner aspect of coronoid process of ulna is dissected free, and soft tissues retracted.

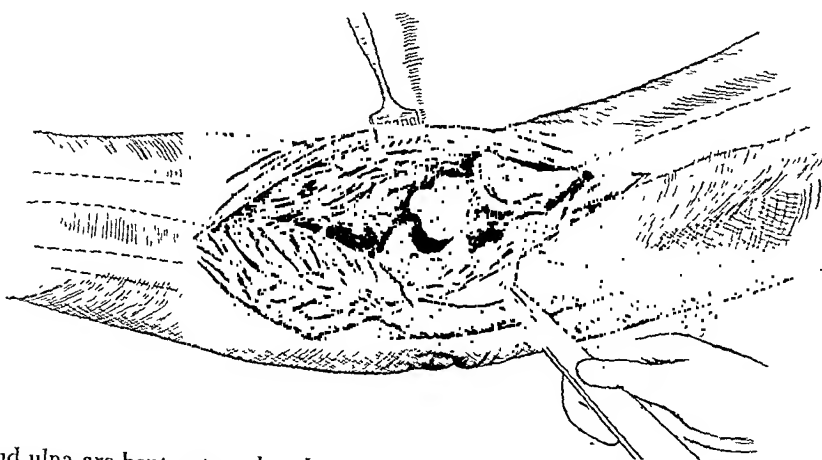


FIG. 4. Radius and ulna are bent outward on humerus, external capsule acting as a hinge. Excellent exposure of articular surfaces and interior of joint can thus be secured.



FIG. 5. Joint capsule is closed and internal epicondyle sutured in its normal position.

permitted. By mere accident, a new and less destructive approach was discovered in the treatment of an unusual fracture about the elbow. This injury consisted of a fracture of the internal epicondyle of the humerus, the fragment being rotated and displaced downward and outward into the joint cavity. Such a fracture was obviously irreducible except by open operation at which time it was found that the fragment of the bone had carried with it the attachment of the flexor group of muscles of the forearm and a portion of the internal capsule of the joint; these were interposed between the sigmoid cavity of the ulna and the trochlear surface of the humerus. During the operation it was demonstrated that the radius and ulna could be dislocated outward on the humerus and that the entire articular surface of the bones as well as all portions of the joint could be inspected. Recognizing the advantages of this complete exposure, the author has since employed a similar approach to the joint on several occasions when accessibility to the interior of the joint was required for the removal of loose bodies or other surgical procedures.

The operative technique may be described as follows: with the elbow flexed at 90 degrees a medial incision is made from 2 in. below to approximately 2 in. above the elbow over the tip of the internal epicondyle. The ulnar nerve is isolated in

the groove posterior to the epicondyle, dissected free and retracted backward. The epicondyle is now dissected from surrounding soft tissue except the common tendinous origin of the flexor muscles of the forearm. With a small osteotome the epicondyle is chiseled loose from in front, backward and turned downward with its muscular attachments. Blunt dissection is next made downward and inward through the muscular fibers of the massive flexor muscles, care being taken to avoid the small nerves to these muscles. The inner aspect of the coronoid process is dissected free, the inner capsule incised, and the periosteum with the anterior and posterior capsule may be stripped from the humerus as far as required for exposure. The elbow joint can now be bent outward, the external capsule acting as a hinge or the joint may be dislocated outward. All parts can be inspected and such surgical measures applied as may be deemed necessary. Care must be taken to retract the median nerve as it passes over the anterior aspect.

The same procedure has been described by Mr. W. H. L. Molesworth¹ of Folkestone, England, and consequently the author claims no priority. However, as the method is an excellent one and was worked out independently before the publication of Molesworth's article it is deemed worthy of further consideration.

¹ *Brit. M. J.*, Oct. 1930.



NEW BONE LENGTHENING APPARATUS FOR THE FEMUR*

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THE advantages of operative lengthening in the femur over lengthening of the lower leg are almost self-evi-

the femur. The more important of these, including the method of Codivilla, Putti, Hoke, and others, seemed to have obvious

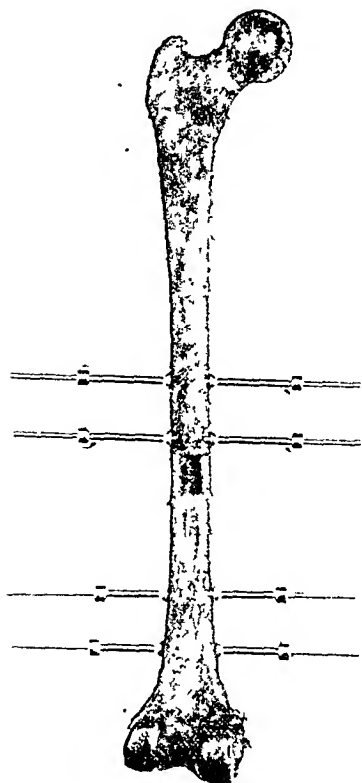


FIG. 1. Femur with pins and collars inserted ready for application of side pieces.

dent. One of the greatest disadvantages which has been encountered in the use of the leg lengthening apparatus as perfected by Dr. Abbott of St. Louis, has been the tendency for the foot to be pulled into valgus. This has been partially compensated for by the addition of a fifth pin in the os calcis and the sectioning of the interosseous membrane. But even this does not appear to have entirely solved the problem. This fact led to a consideration of the various operative procedures previously described for use in lengthening

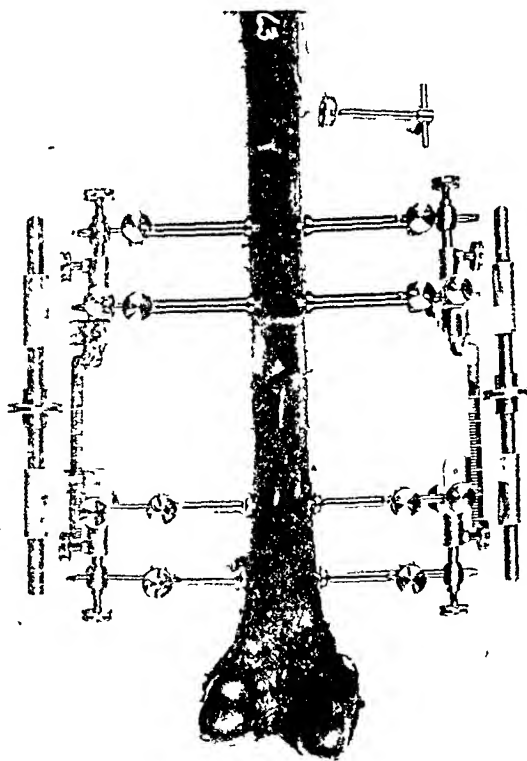


FIG. 2. Bone lengthening apparatus in place in femur. Note gauge which accurately measures amount of length and collars which prevent lateral displacement of fragments.

mechanical drawbacks, particularly the use of plaster, or inability to control the position of the fragments satisfactorily at all times.

An apparatus for operative lengthening of the femur has been developed and successfully used at the University of Missouri hospitals. This paper represents merely a preliminary report. By means of the apparatus described it is possible to control the position of the two fragments throughout the period of lengthening in

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regard both to lateral and anteroposterior position.

The operation for lengthening is readily

Modified Steinman pins are then pushed through the drill holes and a cut made at the point where they reach the skin

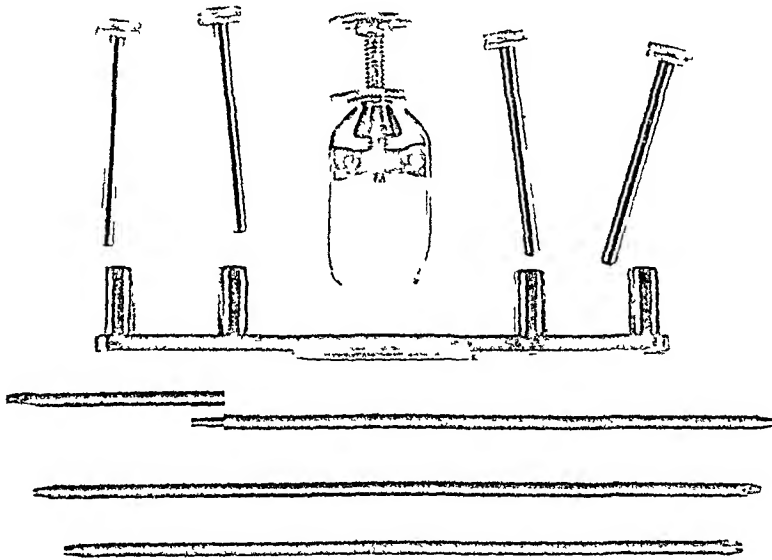


FIG. 3. Guide for accurately drilling desired holes in femur. Modified Steinman pins which unscrew below collar. This eliminates tendency for pin to bend in central portion.

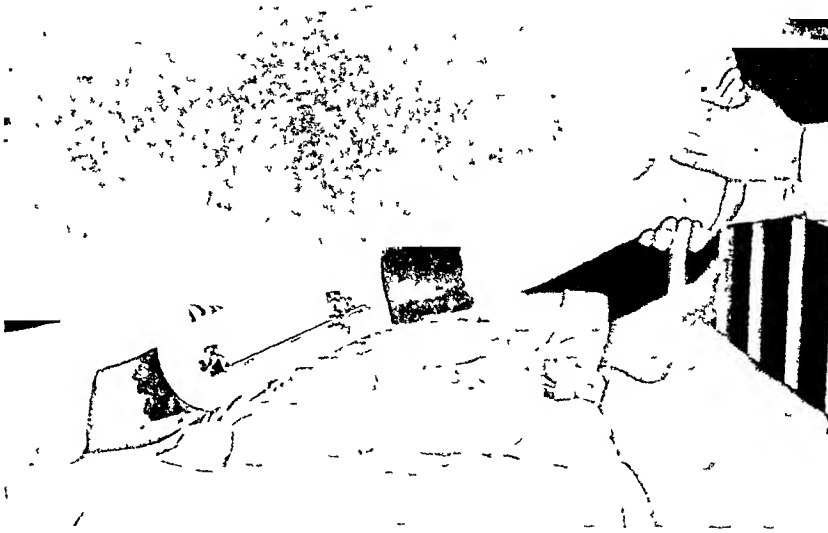


FIG. 4. Lateral clamps after removal of two central pins. Dark portion on skin is skin preparation used at time of operation. In this case only $1\frac{1}{2}$ in. of increased length was necessary.

performed through a lateral incision similar to that used in open reduction of fractures of the lower third of the femur. By means of a special guide, four holes are accurately spaced and drilled in the lower portion of the femur, a measured distance between them being left for the z osteotomy.

on the inner side. Metallic collars are slipped over the pins and brought tightly against the bone (see Fig. 1). These are securely fixed by tightening the thumb screws. A z osteotomy of the femur is done in the usual way and of sufficient spacing to allow for the desired increase in length.

The two side pieces are now applied to the pins and carefully tightened with the wrench. The fragments are then solidly fixed and held by the apparatus. The lateral distraction screws are turned up sufficiently to give $\frac{3}{4}$ in. of lengthening. The outer incision is closed except for a tiny opening about each collar. Sterile dressings are applied and the entire apparatus encased in a large sterile towel. No further support of any kind is necessary. Lengthening is obtained at the rate of $\frac{1}{16}$ in. twice daily or a total lengthening during the twenty-four hour period of $\frac{1}{8}$ in. This is continued until the desired amount is obtained. The knee can be flexed and extended after the first three or four days with practically no discomfort. There is remarkably little swelling and absolute fixation and maintenance of position of the fragments. After four weeks, if the callus seems sufficiently strong (this as a rule may be determined by

x-ray studies) the two central pins and collars are removed and the original side pieces replaced by the two special side clamps shown in the illustration. In the average case four or five weeks seem sufficient time for the callus to be solidified so that these pins may be removed. In six to seven weeks the two distal pins and collars are taken out and a plaster cast may or may not be applied for ten to fourteen days depending on the solidity of the callus formation. At the end of seven to nine weeks there is sufficient new bone formation to allow beginning weight bearing.

This preliminary report is given with the hope that the method may be given a trial by others working with bone lengthening devices. The author wishes to acknowledge his indebtedness to Mr. Gus Tornsjo, Chief Technician, University of Missouri, for his help and cooperation in the manufacture of the apparatus.



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* Continued from p. 62.

INTRA-ARTICULAR STABILIZATION FOR RECURRING DISLOCATION OF THE SHOULDER

TECHNIQUE OF SUSPENSION TO THE ACROMIUM BY AUTOGENOUS FASCIA LATA SUTURE*

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NEW YORK

THE operation herewith described is designed permanently to prevent anterior subglenoid dislocation of the scapulohumeral joint. It involves placing an intra-articular suture through the head of the humerus to the upper posterior portion of the glenoid and fastened to the acromium. The distortion of the capsule and muscles resulting from previous dislocation is correctly compensated for. The result of this operation assures viability of the suture and complete mobility of the joint.

Heretofore, methods for the prevention of dislocation have included plastic work on the osseous structures, capsulorrhaphy, rearrangement of muscular tissues, check and block operations and forms of suspension whereby the humerus is supported from the bony arch above. Extra-articular operations designed for suspension of the humerus include Spitzzy's method¹ of transfixing the head to the coracoid process with silk sutures. This method tends to give an anterior pull to the head of the humerus. Henderson's teno-suspension² makes use of two parallel holes, one through the acromium and the other through the head of the humerus through which the peroneus longus tendon is threaded to form an extra-articular sling. Mechanically both of these methods give an indirect suspension of the humerus which is in reality a reinforcement of the joint. Nicola³ using an intra-articular suspension transplanted the long head of the biceps through the head of the humerus.

The intra-articular technique using autogenous suture material is designed to give posterior traction to the head of the humerus. Its results provide:

1. Natural compensation for correction of the deformity.
2. Firm stabilization of the joint.
3. Greater suture viability.
4. Maximum mobility of the shoulder.

The ultimate success of the operation depends on the strength and viability of the suture used. In the selection of the suture the results of previous research work on the tensile strength and elasticity of fascia lata proved to be valuable.⁴ Living fascia lata was subjected to an engineering tension test and was found to have a breaking strength of about 8000 lb. per square inch and a safe working strength of about 2300 lb. per square inch. A strip of fascia lata of average thickness and $\frac{1}{2}$ in. wide has a safe tensile strength of about 21 lb. Up to this limit fascia lata shows an elasticity of 91 per cent. These tests of strength aid in determining the correct size of suture, while the high elasticity indicates its value for this type of work.

The viability of the autogenous suture has been shown to depend on accurate coaptation between host and scion tissues. Research and clinical work has shown that fascia lata grows solidly to bone and that it is viable after seven years when used intra-articularly.⁵

To facilitate accurate coaptation of the suture in the drill hole and to assist in

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introducing the suture a special suture carrier has been devised (Fig. 8). This has a wedge-shaped eye with slanting teeth

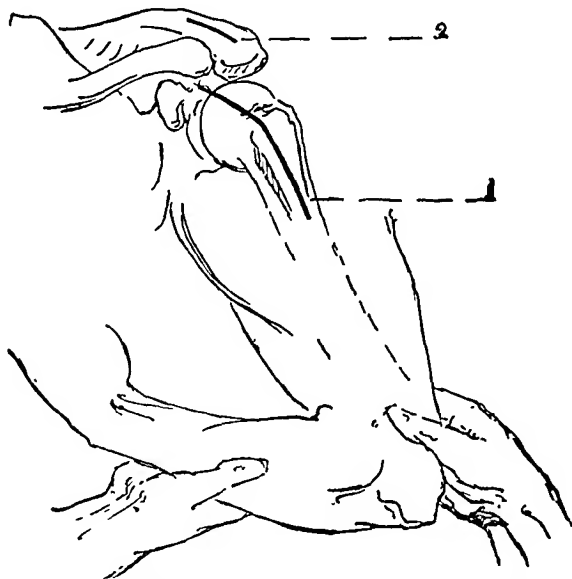


FIG. 1.—Position of shoulder and site of incisions.

and is attached to a flexible wire leader. The wire leader is first threaded through the prepared holes, so that the suture after being firmly wedged in the eye of the needle is easily threaded through the acromium and the head of the humerus.

OPERATIVE TECHNIQUE

In addition to the usual instruments a long bone drill and a suture carrier are required. Preoperative preparation of the operative areas of the shoulder and the thigh of the same side is begun forty-eight hours before the operation.

Two incisions as shown in Figure 1 are used, the first exposing the shoulder just anterior to the long head of the biceps, the second over the upper portion of the acromium. With the forearm flexed the arm is placed at about 40° abduction. Starting well below the capsule of the shoulder, as shown in Fig. 2, a hole is drilled from b through the head of the humerus and continued through the acromium to a. If the drill is not of sufficient length to go through both bones a second hole is drilled from a downward. At d

another hole at right angles to the first, as shown in Figure 3, is drilled to assist in the fixation of the suture. The two operative fields are then packed with saline-moistened gauze while the fascia lata is being removed from the thigh. The suture is then placed in the suture threader, and its flexible leader drawn through the holes from b to a, as shown in Figure 4. A clamp is fixed on the humeral end of the suture to prevent it from pulling through. At the acromial end of the suture a knot is tied as shown in Figure 5, at f, sufficiently large to prevent the suture from pulling through the acromium. The periosteum is then raised from the acromium and the free end of the suture is securely fastened to it with No. 1 chromic. The suture carrier is now placed on the humeral end of the suture and passed through hole d making a loop, as shown in Figures 6 and 7. With firm upward pressure on the elbow forcing the head of the humerus up and back against the glenoid, this loop can be tightened, thus taking up any slack in the suture. The suture is then tied at b, the periosteum raised and the knot securely fastened in position as before. If the technique has been carefully followed, the suture and the osseous structures sustain the entire stress of the fixation.

The three incisions are closed in the ordinary manner, no drainage being used. A large pad is placed in the axilla and the arm supported with adhesive strapping. Note that a cast is not required. A slight movement of the arm is permitted during the first six to eight days. At the end of this period gentle passive motion is allowed. The patient can usually leave the hospital at the end of two weeks. The short period of immobilization is permissible because the technique has been so devised that the fixation depends on the fascia lata itself and not on absorbable suture material.

CASE REPORT

Patient M. M., Male, aged thirty-four years. First examined October 28, 1930. Gave a history of falling through the ice in February,

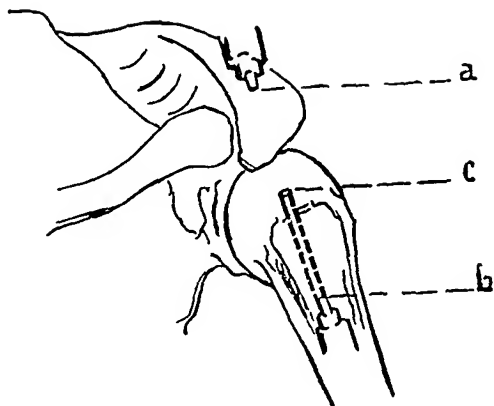


FIG. 2.--Position of drill holes.

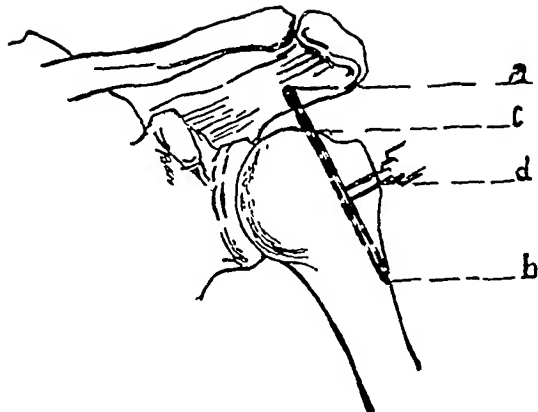


FIG. 3.--Position of drill holes.

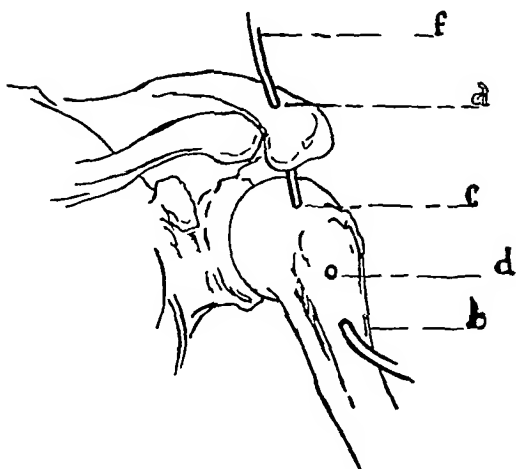


FIG. 4.--Introduction and tying of suture.

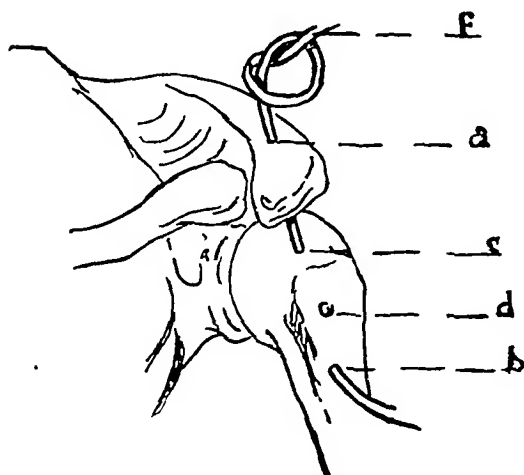


FIG. 5.--Introduction and tying of suture.

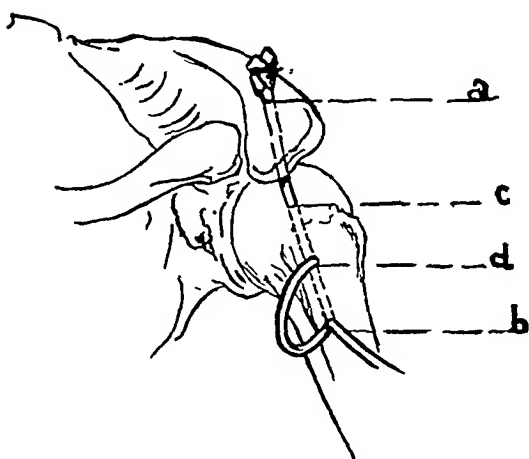


FIG. 6.--Fixation and final position of suture.

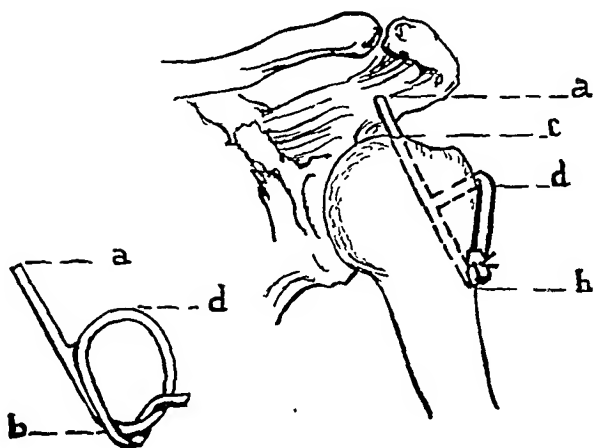


FIG. 7.--Fixation and final position of suture.

1929. He was pulled out by his left arm and first dislocated his shoulder at this time. Reduction possible without anesthetic. The next

joint the capsule was found to be distorted and there was marked relaxation of the musculature. Two incisions, previously described,

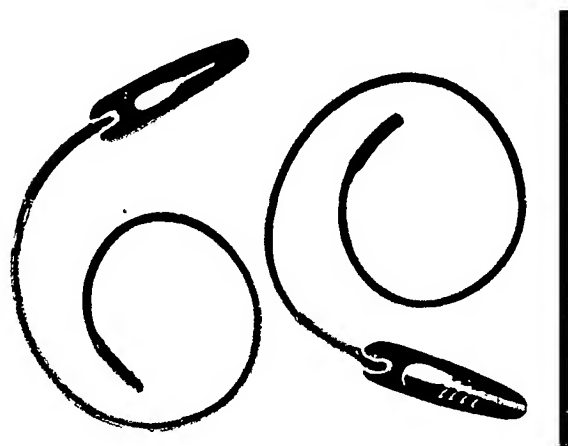


FIG. 8.—Suture carrier.



FIG. 9



FIG 10

dislocation took place February, 1930, when diving. Since that time dislocation had recurred at frequent intervals until at the time of the examination it averaged three times a day and happened as many as six times in twenty-four hours. A slight anterior pull in the upper portion of the shaft of the humerus was sufficient to cause a typical anterior subglenoid dislocation.

Patient was admitted to the Broad Street Hospital and after routine preparation was operated upon November 7, 1930, using the technique described. On exposing the shoulder

gave adequate exposure for placing the suture. The fascia lata suture was removed from the thigh, placed in the suture carrier and inserted without difficulty. The special technique of taking up the slack by a loop through b and d—as described above and illustrated in Figs. 6 and 7, proved effective in holding the head firmly against the upper posterior portion of the glenoid. The ends of the suture were fastened to the periosteum with No. 1 chromic. The shoulder joint was closed with No. 1 chromic, for the capsule and muscles and No. 1 plain catgut for the skin. Three retention sutures of silk-worm gut were also used. The skin and superficial layers of the thigh were closed with silk, the edges of the fascia lata not being approximated. Adhesive strapping with a large pad in the axilla was used for six days. At the end of this time passive motion was permitted.

The patient was discharged from the hospital in two weeks. He was able to return to work in one month. Since that time he has used his arm in all kinds of work and no trouble has been encountered. The illustrations show the movement at the present time. He was last seen November 4, 1931.

[For References see p. 90.]

THE OPERATIVE CURE OF HALLUX VALGUS AND BUNIONS*

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IT is generally conceded that when there are multiple therapeutic measures for an ailment, it is more than likely that no one of them is entirely satisfactory. This is true of the present-day treatment of hallux valgus and bunions. There are in vogue many types of operations, some simple, others complicated, each advocated by a surgeon or group of surgeons specially skilled in its application. Were the individual to seek advice early, when the prominence of the metatarsophalangeal joint of the big toe is slight, some mild measure, such as a special shoe or a night splint, would suffice to give relief and to prevent increase of deformity. But actually a hallux valgus continues for many years before the symptoms become annoying, and then it is usually found that the pathological changes both in the big toe joint and the adjacent structures are so marked that surgical attention is imperative.

In analyzing the various operations it is found that each of them is concerned with and aims to correct some special part of the pathological anatomy of hallux valgus and bunions, but either leaves some portion of the deformity, or results in a defect that interferes with the perfect function of the foot. For instance, in one operation the head of the first metatarsal is removed. In this procedure the deformity is corrected, but an important element in the support of the front of the foot is removed, and the motion at the metatarsophalangeal joint is greatly limited, thus impairing the function of the foot. In another operation the proximal extremity of the first phalanx is excised. This shortens the big toe and also limits the motion at the metatarsophalangeal joint. In a third operation only the overgrowth of the bone

at the distal end of the metatarsal bone (the so-called exostosis) is removed. This procedure, although perhaps sufficient for the milder grade, does not correct the valgus of the big toe and does not prevent the recurrence of a bunion. Just so there are other operations, but since each has some disadvantages in addition to its advantages, there still remains the need for some operation which will correct the pathology without interfering with the function. It is the purpose of this communication to describe an operation which I believe fulfills these requirements. When I first performed this operation I was unaware that the principle upon which it is based was enunciated many years ago by Dr. Riedl on the Continent, and reiterated six years ago by Dr. Walter Truslow of our own city. The technique which I employ is somewhat different from that advised by either Dr. Riedl or Dr. Truslow, yields a more complete correction of the deformity and gives every promise of satisfactory and permanent results.

PATHOLOGICAL ANATOMY

When one examines a foot with hallux valgus and bunion, the most conspicuous feature of the deformity is the prominence of the metatarsophalangeal joint. In this enlargement there may be a bursa or bunion with the skin over it thickened or calloused. On palpation one feels a general overgrowth of the bony structures underneath the bursa. The big toe is deflected outward to a greater or less degree; in the severe cases it may lie under the second and third toes. The foot is very wide at the level of the metatarsophalangeal joints and narrow at the shank or tarsal region. The long extensor tendon of the big toe is

* Read at the Orthopedic Section of New York Academy of Medicine, April 24, 1931.

also deflected outward and by its action tends to maintain the valgus of the big toe.



FIG. 1. Typical case of hallux valgus and bunions of moderate degree. Plane of joint between internal cuneiform and first metatarsal is oblique. First metatarsal bone is markedly adducted. Large bony overgrowth on inner side of head of first metatarsal. Outward displacement of big toe and of sesamoid bones.

A dorsoventral x-ray film of the foot shows several important pathologic changes (Fig. 1). The most striking appearance is the adduction of the first metatarsal bone. While the long axes of the other metatarsal bones are parallel to the long axis of the foot, that of the first metatarsal is turned inward and forms an angle of about 25° with it. Furthermore, while the outer tarsometatarsal joints are horizontal, the tarsometatarsal joint of the big toe is oblique. The sesamoid bones of the big toe are displaced outward. The head of the first metatarsal bone shows an overgrowth and enlargement of its inner, non-articulating extremity. The big toe is in varying degrees of valgus. Of these changes in the bony structure of the foot I consider the first two mentioned,

namely, the adduction of the first metatarsal bone and the obliquity of the first tarsometatarsal joint, as primary, and the



FIG. 2. Feet of a muscular man. Some adduction of first metatarsal bones and obliquity of tarsometatarsal joints, but no bunion formation because the man has always worn broad toe shoes and has avoided outward pressure on big toes.

others as secondary. I find some degree of adduction of the first metatarsal bone in practically every foot. Manifestly it is an atavistic remnant of the period when the big toe was very mobile and had prehensile qualities.

MECHANISM OF THE PRODUCTION OF HALLUX VALGUS

The usual cause of hallux valgus is the wearing of pointed shoes. I believe also that tight and short stockings frequently initiate outward deflection of the big toe. Occasionally the deformity may be hereditary, unilateral or may even be found in people, as noted by Erlacher, who do not wear shoes. These instances are exceptional, constitute a small percentage and do not alter the fact of the common cause. In Figure 2 is shown the x-ray of the feet of a vigorous man who has always worn broad toe shoes. He has fairly marked adduction of the first metatarsal bones, but he has no bunions. If such a foot is

placed in a pointed shoe the big toe is pressed outward and gradually becomes fixed in a position of valgus. As the big

individual and the degree and duration of the abuse of the foot. As the big toe is pushed outward the tendons on its dorsal

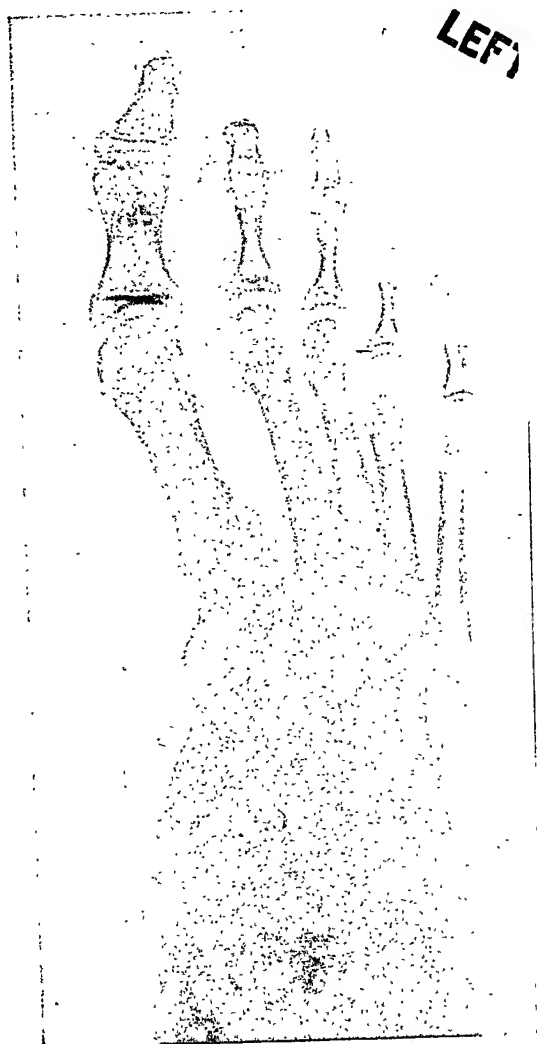


FIG. 3. This x-ray is that of the foot of a child who has worn broad toe shoes. Although there is marked obliquity of first tarsometatarsal joint and adduction of first metatarsal, no outward deflection of big toe and no bunion formation.

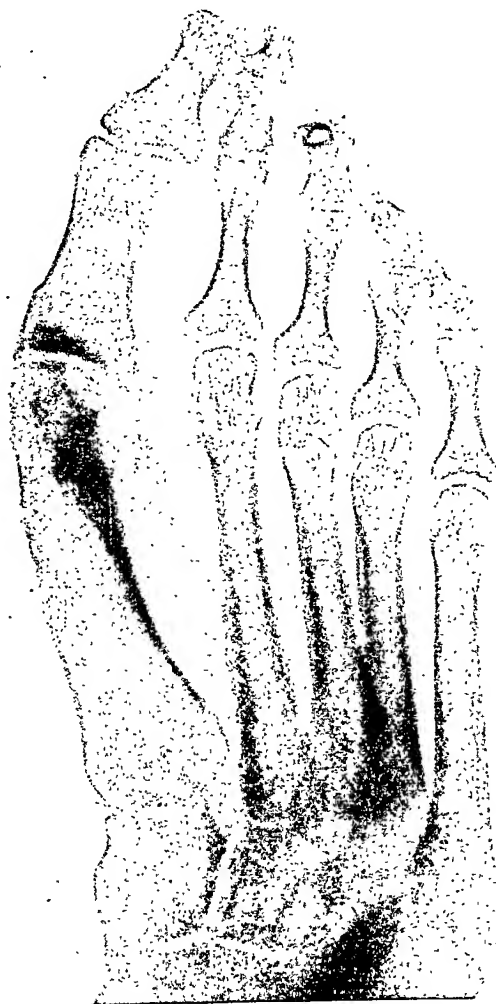


FIG. 4. Hallux valgus in a child fourteen years of age. Condition severe and required operation. Simple removal of bony overgrowth relieved immediate symptoms, but did not cure the condition. She still has a hallux valgus, adduction of first metatarsal bone and obliquity of tarsometatarsal joint.

toe is deflected outward, the inner side of the distal extremity of the first metatarsal bone is brought into closer contact with the leather of the shoe and is thus subjected to friction. The physiological response to friction is the formation of new bone and of a bursa or bunion with thickening of the skin over it. The degree of valgus of the big toe and the size and sensitiveness of the bursa depend upon the type of the shoe worn, the general activity of the

and plantar surfaces are displaced and their function is disturbed and altered. Ultimately these tendons, because of their altered position, tend to maintain and to increase the deformity of the big toe.

In Figure 3 we see the foot of a child who has always worn broad toe shoes. This foot is that of a well developed boy. There is marked adduction of the first metatarsal bone with obliquity of the

corresponding tarsometatarsal joint, but the big toe is in line with the inner border of the foot, and the boy has no symptoms.

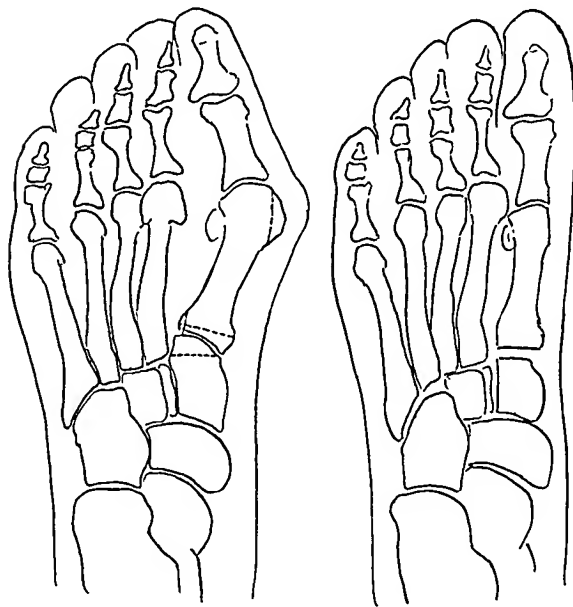


FIG. 5A

FIG. 5B

FIG. 5A. Foot with hallux valgus. Dotted lines indicate portions of bone excised in author's operation. B. Postoperative alignment of big toe and first metatarsal bone with inner border of foot.

On the other hand we see in Figure 4 also the foot of a child, a girl of fourteen years of age. She has the same degree of adduction of the first metatarsal and no greater obliquity of the tarsometatarsal joint than had the boy just mentioned, but she had been wearing so-called "stylish" pointed shoes and hence developed a hallux valgus and bunions.

TREATMENT OF HALLUX VALGUS AND BUNIONS

While the immediate cause of the discomfort and disability in hallux valgus is the enlargement in the region of the metatarsophalangeal joint of the big toe, and the easiest and most obvious means of relief is to reduce that enlargement by excision of the bony overgrowth and overlying bursa, it has always been appreciated that this simple operation, while sometimes sufficient and satisfying to

the patient, does not really cure the deformity. For instance, in the case of the patient with hallux valgus, whose x-ray is shown in Figure 4, the flattening in the region of the metatarsophalangeal joint shows that the bony overgrowth has been removed, but the valgus of the big toe, originally corrected, has recurred. There is still marked adduction of the first metatarsal bone and no change in the obliquity of the tarsometatarsal joint. Consequently the basic etiologic factors remain and the whole group of disturbing symptoms are likely to reappear. To correct the primary cause of hallux valgus one must change the plane of the first tarsometatarsal joint from oblique to horizontal, and reduce the adduction of the first metatarsal bone. It is readily appreciated that if the first metatarsal bone could be made parallel to the long axis of the foot, it would be an easy matter to straighten the big toe and to keep it in line with the inner border of the foot.

The importance of the obliquity or adduction of the first metatarsal bone in the causation of hallux valgus has long been appreciated, and various operations have been devised for its correction, such as, cuneiform resection of the head of the metatarsal bone, wedge resection of the metatarsal just behind the head, oblique osteotomy of the shaft, removal of a wedge from the tarsometatarsal joint (Truslow's operation), removal of a wedge of bone from the internal cuneiform (Riedl's operation), and so forth. These operations have not been entirely satisfactory because the adduction of the first metatarsal was not reduced sufficiently or the secondary changes, such as the overgrowth of bone on the metatarsal and the valgus of the big toe, were incompletely corrected. It therefore occurred to me that if a double wedge resection were performed at the tarsometatarsal joint and the first metatarsal bone were thoroughly mobilized, it could be brought to a position parallel with the other metatarsals, and its adduction, the chief element in this deformity, could be

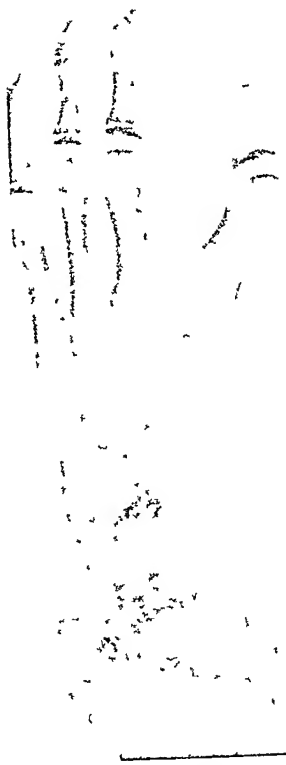


FIG. 6A



FIG 6B

FIG. 6A. Congenital deformity of left foot in a boy eight years of age. Marked adduction of first metatarsal bone with valgus of big toe. B. Postoperative x-ray showing reduction of adduction of first metatarsal bone and complete correction of hallux valgus.



FIG. 7A



FIG. 7B

FIG. 7A. Feet of adult woman. Marked hallux valgus and bunions. Note adduction of first metatarsal bones and obliquity of corresponding tarsometatarsal joint. B. Postoperative film showing complete correction of all of elements of deformity of hallux valgus.

corrected. Acting upon this thought I undertook the following operation.

AUTHOR'S OPERATION

A one and one quarter inch incision is made on the dorsum of the foot over the first tarsometatarsal joint, lateral to the extensor proprius hallucis tendon. The incision is extended down through the periosteum to bone. The soft tissues are elevated from the internal cuneiform and the proximal $\frac{3}{4}$ in. of the metatarsal bone. When the edges of the wound are retracted, there are exposed the internal cuneiform, the medial part of the middle cuneiform, the base of the first metatarsal and the inner aspect of the base of the second metatarsal bones. A wedge, with its base facing inward and measuring $\frac{1}{4}$ in., is removed from the proximal articular extremity of the first metatarsal bone, as shown in the drawing marked Figure 5. A similar wedge, with its base facing outward, is removed from the adjacent surface of the internal cuneiform bone. The soft tissues are elevated from the proximal extremity of the first metatarsal over its entire circumference, thus thoroughly mobilizing it. The first metatarsal bone is then manipulated until its adduction is corrected and its freshly cut surface brought into contact with that of the internal cuneiform. Frequently there is a shoulder or projection of bone on the outer side of the base of the first metatarsal, or the inner side of the base of the second metatarsal, which interferes with the free motion of the first metatarsal and has to be removed. At this point it is found that simple outward digital pressure on the distal extremity of the first metatarsal bone is enough to correct its adduction. The wound is closed with several interrupted catgut sutures through the periosteum and other soft tissues over the bases of the first and second metatarsal bones to approximate them, and a continuous line of silk suture for the skin.

A short incision is then made on the inner side of the metatarsophalangeal joint of the big toe over the bunion. The

skin edges are retracted. A U incision is made into the bursa and the capsule of the joint, elevating a tongue-like process with its base above, attached to the proximal phalanx. The overgrowth of bone on the superior and especially the inner side of the head of the metatarsal bone is removed and the raw surface filed smooth. The articulating portion of the head is not disturbed. There is usually a lip of bone on the inner side of the base of the phalanx which is part of the bony overgrowth and should be removed. The big toe is adducted and held in position by suturing the tongue-like segment of the bursal wall and joint capsule to the tissues on the inner side of the metatarsal bone. The wound is closed with a few interrupted catgut sutures for the deep tissues and silk for the skin.

The deformity has now been corrected, the big toe and the first metatarsal bone are in line with the inner border of the foot. Small sponges soaked in alcohol are placed on the wounds. These are covered with one or two dry larger gauze sponges. A sterile flannel bandage is rolled around the foot, making pressure over the distal extremity of the first metatarsal bone in order to hold it close and parallel to the second metatarsal. A few strips of adhesive plaster over the flannel bandage help to reinforce the support. As an additional means of adducting the big toe a pad of gauze or cotton is secured between the big and second toes. Although there are two distinct operations on each foot, both are very simple and neither takes more than ten or fifteen minutes.

Weight bearing is prohibited for three to four weeks to allow for complete healing of all the tissues. A light foot support is then provided and the patient is urged to wear a modified orthopedic shoe.

Since the operation of the type here described was first performed about a year ago, the author cannot as yet report a large series of cases. Eight patients have been operated on, two with unilateral and the rest with bilateral hallux valgus. All of them have done well. The deformity has in

each case been completely corrected and the patients have had no complaints. In one case, in my desire to remove all of the overgrowth on the distal extremity of the metatarsal bone, I excised too much bone, including an unnecessary and unwarranted amount of the articular surface.

ILLUSTRATIVE CASES

E. P., a boy eight years of age, was my first case. He was operated on one year ago. He had a congenital absence of one toe and a hallux valgus. The x-ray picture (Fig. 6 A) showed four toes, four metatarsals and only two cuneiforms. There was marked obliquity of the first tarsometatarsal joint and adduction of the first metatarsal. He had the typical operation as here described and Fig. 6 B shows the result. The postoperative external appearance of the foot is pleasing, and the patient and his parents are delighted with the cosmetic improvement.

M. B., a woman of about forty, consulted me for very painful bunions on both feet. The x-ray picture (Fig. 7 A) shows a marked condition of bilateral hallux valgus and bunions with all the characteristics described previously. Both feet were operated on and a very good result obtained. The postoperative x-ray pictures are seen in Fig. 7 B. These show normal alinement of the big toes, excision of the bunions and bony overgrowths and correction of the adduction of the metatarsal bones.

The removal of some bone at the tarsometatarsal joint brings the tip of the big toe behind that of the second toe, which helps to prevent recurrence of valgus of the big toe.

SUMMARY

The main basic factors in the etiology of hallux valgus and bunions are the adduction of the metatarsal bone of the big toe

and the obliquity of its tarsometatarsal joint.

The conspicuous and obvious causes of the discomfort and disability are the valgus of the big toe, bony overgrowth at the base of the big toe and the overlying bursa or bunion.

The author's operation aims to correct all of the pathological changes without disturbing the function of the big toe joint or the weight bearing surface of the head of the first metatarsal.

The adduction of the first metatarsal bone is corrected by the removal of a double wedge from the tarsometatarsal joint, the mobilization of the metatarsal bone and the manual approximation of the first and the second metatarsal.

The overgrowth of bone on the head of the metatarsal and the bunion are excised through a separate incision.

The correction of the valgus of the big toe is assured by securing to the metatarsal bone a tongue of strong tissue, consisting of bursal wall and capsule, which is attached to the base of the phalanx.

Care is exercised not to remove or in any way disturb the articulating portion of the head of the metatarsal bone. This accomplishes two results, namely, the support of the forefoot is not altered and the mobility of the big toe is not diminished.

By bringing the big toe into line with the inner border of the foot, the sesamoid bones are returned to their normal relation to the head of the metatarsal, and the dorsal and plantar tendons of the big toe are brought into a normal or nearly normal position, where they can function properly.



OSTEOMYELITIS OF THE VERTEBRAE

WITH A REPORT OF TWO CASES SIMULATING PERINEPHRITIC ABSCESS*

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ALTHOUGH the first cases of osteomyelitis of the vertebrae were reported by Lannelogue in 1879, it was not until 1895 and 1899 when O. Hahn⁵ reported a series of cases, that any important contribution was made on this important subject. Hahn found 51 cases of acute osteomyelitis of small and irregular bones out of a total of 661 cases of osteomyelitis involving all of the bones of the body; and out of the 51 cases, there was only 1 case of osteomyelitis of the vertebrae, an incidence of 1:661. The next important contribution appearing in the literature was by Makins and Abbott⁷ in 1896, followed by an interesting paper by Daverne² in 1903. Three years later the well known article by Donati³ appeared in which the author summarized the cases of osteomyelitis of the vertebrae of various European clinics, collecting 55 cases and adding 1 case of his own. The meningeal complications of the disease were described by Goebell⁴ in 1910. An interesting case was described by Ashurst and Wadsworth¹ in which the diagnosis was made at post mortem. Four additional cases were reported by Volkmann⁹ in 1915 in addition to 87 cases collected from the literature up to that time. In 1920 another paper appeared by Schwartz⁸ dealing with the intraspinal complications of the disease. The most recent communication is by Wilensky¹⁰ in 1929 in which the subject of osteomyelitis is treated as a whole with special reference to the pathogenesis. He reviews 9 additional cases from the records of the Mount Sinai Hospital.

The general conclusions that may be drawn from these reports are that the disease is difficult to diagnose, has a high mortality, and is liable to dangerous and disagreeable complications.

INCIDENCE

The frequency of this disease varies between 0.2 per cent in Hahn's series to 1.5 per cent in the Mount Sinai Hospital series as reported by Wilensky.

Sex: In Volkmann's series, there was 72 per cent of males, in Donati's 68 per cent and in Wilensky's series, 55 per cent.

Age:

	Donati	Daverne	Makin & Abbott	Mt. Sinai
1 to 10	15	12	5	2
10 to 20	24	6	11	
20 to 30	11	9	3	3
Over 30	2	..	..	4

The majority of the cases reported occurred in the first three decades; and 75 per cent of the cases were under twenty years of age.

Vertebrae Involved:

	Daverne	Makin & Abbott	Mt. Sinai
Cervical.....	7	3	2
Dorsal.....	12	5	2
Lumbar.....	17	10	4
Sacral.....	5	3	1

The lumbodorsal spine is most frequently involved.

Pathogenesis: The pathogenesis of acute osteomyelitis of a vertebra is no different from that of an acute osteomyelitis of any other bone of the body. It represents a metastatic complication in the course of a general bacteremia starting from a focus of infection existing elsewhere in the body.

Henle⁶ in his monograph states that E. Frankel had found in his post-mortem studies that cultures made from vertebrae

* Submitted for publication April 28, 1931.

revealed the pneumococcus in people dying of pneumonia; the streptococcus in cases of erysipelas, pulmonary abscesses and diphtheria; and the staphylococcus in cases of pyemia from foci such as furuncles, carbuncles and paronychia.

Whether the lesion be a carbuncle, a furuncle or an infected tonsil, the cause of the spread from the focus to the point of the metastatic lesion as so ably shown by Wilensky, is an infected thrombus situated at or in the immediate neighborhood of the original lesion and communicating at some point with the general circulation. Bacteria or infected emboli lodge in arteries and block them, giving rise to secondary lesions in tissues depending upon these arteries for nutriment. Bones are especial sites of predilection for such emboli because of the arrangement of their blood supply. This is especially true of growing bones where there is a well marked separation between epiphysis and diaphysis.

Although a history of trauma is frequently elicited from these patients, it acts only as an accessory cause by interfering with the circulation of the bone and thus establishing a *locus minoris resistentiae*. When the embolus lodges in a vessel there results either a thromboarteritis or thrombophlebitis depending upon whether an artery or vein is involved. This phenomenon holds true for bone as it does for any other tissue. As soon as this insult occurs a bone infarct or area of bone necrosis results, due to interference with the circulation.

Owing to the peculiar anatomical structure of the spinal column, and to the bizarre arrangement of the vascular system of the individual vertebrae, the bodies receiving more abundant circulation than the components of the vertebral arches, embolic lesions do not follow the same course as in osteomyelitis of other bones. The lesions are usually small and more prone to affect the transverse processes, pedicles and spinous processes in the dorsal and lumbar portions of the spine. The

bodies of the vertebrae are more frequently involved in the cervical region. Donati has shown in his series that the spinous processes are affected most frequently, the pedicles next and the transverse processes were involved least frequently.

Pus, once formed in the bone, spreads along well defined paths depending upon the part of the spine involved. In the cervical region, the thrombotic process starts in the body of the vertebra. Pus accumulates between the cortex and periosteum and a retropharyngeal abscess is the result. If not recognized and drained, the pus may spread downward to the posterior mediastinum or upward to the base of the skull. When the osteomyelitis starts on the ventral surface of the transverse process, the pus spreads forward between the longus colli muscles and the anterior scalene muscles and the residual abscess points in the posterior triangle of the neck. Should the process start on the posterior surface of the transverse process, in the laminae or spinous processes, there results a slow forming abscess which burrows between the layers of the deep muscles of the back of the neck and must be drained through a deep incision in the posterior aspect of the neck.

Osteomyelitis of the dorsal spine usually involves the components of the vertebral arch. When the process starts on the anterior aspect of a transverse process or in a pedicle, the suppuration spreads down beneath the sheath of the psoas muscle and gives rise to a psoas abscess. With involvement of the radicles of the arch, the pus spreads backward between the layers of the deep spinal muscles giving rise to abscesses which lie between the angle of the ribs and the lateral posterior aspect of the laminae and spinous processes. Rarely is the body of the vertebra involved in this region; and in such cases a posterior mediastinal abscess develops with its grave complications such as purulent pleuritis and pericarditis.

The points of predilection in the lumbar spine are similar to those in the dorsal,

namely the components of the vertebral arches. Involvement of the anterior surface of the transverse processes and pedicles gives rise to large retroperitoneal pus accumulations. These may spread upwards to form subphrenic abscesses or laterally to involve the perinephritic spaces. Deep seated abscesses in the muscles of the back follow when the infection originates in the posterior aspect of the transverse processes, laminae and the spinous processes.

Osteomyelitis of the sacrum and coccyx gives rise to subcutaneous abscess, when the process starts in the posterior aspect of the bone. Anterior involvement results in abscess formation in the hollow of the sacrum which may spread through the sacrosclatic notch up between the layers of gluteal muscles and give rise to gluteal abscesses; or when the pus burrows downward, it may give rise to para-anal abscesses.

It is not the purpose of this communication to deal with the spinal cord and meningeal complications that may follow osteomyelitis of the vertebrae when the focus points inward to the spinal canal rather than externally. Suffice it to say that such complications do occur and when they do the prognosis is exceedingly grave.

SYMPTOMS

In the acute type of the disease, the symptoms are general and local. The general systemic symptoms of osteomyelitis of the vertebrae do not differ from those due to osteomyelitis in any other bone of the body. The clinical picture in the fulminating cases is that of a profound infection ushered in with chills and high temperature, and not unusually terminating fatally even before the local symptoms become manifest. In those cases terminating in death, a focus of osteomyelitis when found is only incidental and of no great consequence. The outstanding feature of the case is the general bacteremia, while the embolic process in the bone has really very little to do with the picture.

When the infection is milder, the symptoms frequently point to the focus in the vertebra. Because of the transient and temporary nature of the bacteremia in this type of case, no organisms are found in the blood stream and the general systematic symptoms are of little consequence.

There is another variety of this disease in which the well-defined picture of osteomyelitis of a vertebra is associated with abundant symptoms and a positive blood culture. It is possible that a patient in this group when placed upon appropriate treatment may pass over into the group previously described: that is, of osteomyelitis without symptoms of blood invasion. The converse of this may also be true, where a case of the second group becomes virulent and in turn sets up a second attack of fulminating bacteremia from which the patient may succumb.

The disease may commence spontaneously or follow a trauma with chills, fever and general malaise. Should the organism be of the virulent type, the patient will appear extremely ill and prostrated. In mild infections, the case resembles one of mild grippe. Within forty-eight or seventy-two hours, symptoms appear which point directly to the affected spine. The segment of spine involved becomes fixed as a result of a protective spasm of the spinal muscles. Careful inspection may show edema of the skin and soft parts over the involved vertebrae. So diffuse may the affection of the soft parts be, at times, that the symptoms and signs point directly to some neighboring organ that they cover even though that organ itself be perfectly normal.

Pain is the earliest symptom referable to the involved vertebra. It may be general or localized. It is aggravated by motion in which the spine participates. Percussion over the affected bone elicits marked tenderness. When the suppurative process has broken through the periosteum and given rise to an abscess, the symptoms and signs change to conform to the site and nature of the abscess, a psoas ab-

cess giving its characteristic clinical picture and a retropharyngeal an entirely different one. It is not the purpose of this paper to describe the symptomatology of all the clinical entities that may complicate osteomyelitis of the vertebrae; suffice it to say, however, that at times the clinical picture associated with these residual abscesses completely masks the pathologic process that gives rise to them.

PROGNOSIS

The prognosis in this disease is grave, the mortality ranging between 48 to 71 per cent. The prognosis is better in affections of the arches than in those of the bodies of the vertebrae, since they can be more easily recognized and operated upon. The mortality is highest when the disease is localized to the lumbar region.

Donati	Cases	Deaths	Percentage
Lumbar region	26	17	65.4
Dorsal region	18	5	27.7
Cervical	9	4	44.4
Diffuse	3	1	33.3

Treatment: The treatment of this disease depends upon the type of involvement present. In the group of fulminating infections any attempt at therapy is futile. Incision and mild curettement of the diseased vertebra for the purpose of diminishing the bacteremia may control the less virulent type of infection. The treatment best suited to the most frequent type of cases encountered, namely those where the bacteremia, if present at all, is of moderate virulence, resolves itself down to the release of pus and the removal of sufficient necrotic bone to control the infection without impairing the function of the spinal column.

The second feature in the treatment is proper incision and drainage wherever and whenever possible, of residual abscesses which are in fact complications of the osteomyelitis of the vertebrae, a discussion of which is outside the scope of this communication.

Two cases of osteomyelitis of the vertebrae are here reported, where the signs and symptoms pointed to involvement of the perirenal tissues.

CASE 1. M. E. C., a man aged twenty-eight, first seen August 1st, 1929, complaining of excruciating pain in the right lumbar region radiating to flank and right hypochondrium and accompanied by fever and constipation of one week's duration. The pain was aggravated on breathing and during changes of position. Three weeks prior to the onset of symptoms a furuncle of the right leg was incised and drained.

The physical examination revealed a male white patient, twenty-eight years of age with dry tongue, appearing acutely ill and having apparently lost considerable weight. The muscles of the right loin and upper abdomen were rigid and there was marked right costo-vertebral angle tenderness. The right upper quadrant of the abdomen was also tender. Owing to the rigidity of the muscles the right kidney could not be palpated. Temperature 102.4°F. Urine showed a faint trace of albumin and an occasional white blood cell. Blood count: red blood corpuscles, 4,480,000. White blood corpuscles 22,400. Polymorphonuclear leucocytes 83 per cent. Blood culture was sterile after seventy-two hours. X-ray examination of spine was negative.

Operation: August 3, 1929. The right kidney was exposed through a 6 in. Albarran incision. It was found to be normal in size, shape, consistency and appearance. The capsule stripped readily and no cortical abscesses were seen. The perirenal fat was also normal. Knowing that a suppurative process must be responsible for the clinical picture, a diagnosis of possible osteomyelitis of a vertebra was entertained. With this thought in mind, the kidney was replaced and the incision gradually extended upwards to the right of and parallel to the vertebral column. The fibers of the erect or spinae muscle were divided. A finger was then insinuated between the laminae of the vertebrae and the muscles attached to them. This maneuver was carried upward to the level of the eleventh dorsal vertebra. At the point, a drop of pus could be seen coming from a small fistulous opening. A probe directed in through this opening entered a large abscess cavity. The opening into the cavity saw

enlarged first with a dressing forceps and then with the tip of the index finger and about two tablespoonfuls of thick creamy pus and necrotic material evacuated. At the bottom of the cavity, one could feel bare bone which proved to be the spinous process of the eleventh dorsal vertebra and the right lamina of that vertebra. The bone was gently curetted and the abscess cavity swabbed with an iodine sponge. The abscess was well-drained and the wound closed in layers.

Culture made of the pus showed a pure growth of *Staphylococcus citreus*.

The wound was dakinized every two hours. For two weeks, the temperature ranged between 100° and 102°F. and then dropped to normal. At the time the wound discharged less pus and one could distinctly feel dead bone in its depth. Although no visible sequestrum came away, the wound closed and on September 13, 1929, the patient was discharged well.

COMMENT

This is a case of acute osteomyelitis occurring in a dorsal vertebra secondary to a furuncle of the leg, giving signs and symptoms of a perinephritic abscess. In spite of the positive findings at operation, x-ray examination of the spine was negative, proving that this disease cannot always be diagnosed from x-ray films. Another interesting feature of this case was the failure of a visible sequestrum to come away from the wound prior to its healing. This is quite characteristic of osteomyelitis of the spinal vertebrae.

CASE II. M. S., a man aged fifty-two years, first seen September 25, 1929, complaining of pain in the left lumbar region of nine years' duration. The pain has occurred in the form of attacks starting in the left lumbar region and radiating to the left thigh and leg. There were no urinary symptoms.

Ten years ago while in Russia, he was stabbed in the back with a bayonet. The bayonet passed through the left side of the back and its point lodged in the spinal column. This accident occurred during the course of a pogrom. After passing through a stormy convalescence of several weeks, in a hospital, he was finally discharged as well. He had no

symptoms for one year and then began to have the attacks described here. Shortly before this accident occurred the patient had had typhus.

Physical examination was essentially negative with the exception of exquisite tenderness over the left lumbar region and in the left lower quadrant of the abdomen with spasticity of the lumbar muscles. Tenderness was also present in left buttock. Temperature 100°F.

Cystoscopy revealed a normal bladder. Both kidneys were easily catheterized. There was considerable retention in the left kidney. A few red blood cells were found in the specimens from both kidneys. The phenolsulphone plithalein concentration in the urine from both kidneys was good and equal.

A left pyelogram showed the pelvis to be contracted and the minor calices blunted. The flat plates were negative as regards the kidneys and bladder but a fusion between the fourth and fifth lumbar vertebrae was noted.

Operation, October 29, 1929. The left kidney was exposed through a 6 in. Albarran incision. The perirenal tissues along the posterior surface of the kidney were dense and sclerotic. This induration was present in the musculature and subcutaneous fat in the region of the posterior part of the wound. The posterior leaf of the fatty capsule of the kidney was also of stony hard consistency. Although the kidney was isolated with great difficulty it was found to be free of any gross pathologic changes.

The incision was extended backwards toward the spine and the deep tissues divided. In doing this an abscess cavity was entered which extended from the posterior renal fossa upwards toward the diaphragm and backward toward the spine. Upon opening the abscess cavity about two tablespoonfuls of thick, creamy pus and necrotic material were liberated. In the bottom of the abscess cavity, one could feel dead bone which proved to be the left transverse process of the first lumbar vertebra.

The cavity was swabbed with mercurochrome and the bone gently curetted. Suitable drains were inserted and the wound closed in layers. Culture of the pus showed a pure growth of *Staphylococcus aureus*.

During the first week after operation, the temperature ranged between 100° and 101°F.

The wound was dakinized every two hours. All tubes were removed on November 18 and the patient discharged in good condition November 24, 1929, twenty-five days after the operation.

COMMENT

This represents the case of a man fifty-two years of age who one year prior to the onset of symptoms was stabbed in the back with a bayonet. For nine years, he had had attacks of pain in the left lumbar region. At operation an osteomyelitis was found of the left first transverse process with a paravertebral abscess. It appears that the infection in this case was carried in from the outside through the agency of a foreign body. Whether the infection of the bone preceded the paravertebral infection or was the result of it is difficult to state. Suffice it to say, however, that both were present at the time of operation and from the appearance of the perirenal tissues seemed to have existed for many years. It is possible that we are here dealing with a secondary infection of a chronic osteomyelitis process that might have occurred through the blood stream, because it is hard to conceive that a pure growth of *Staphylococcus aureus* could have been present for ten years without giving rise to other foci of infection or to a general pyemia. This case also shows that x-ray examination of the spine can be of little aid in making a diagnosis of osteomyelitis of a vertebra. The symptoms seemed to point to an infection of the left kidney but at operation the kidney appeared normal.

The perirenal tissue however was secondarily involved.

CONCLUSIONS

1. Osteomyelitis of the vertebrae is a rare disease.
2. Osteomyelitis of the vertebrae when situated in the lower dorsal or lumbar spine can simulate diseases of the kidney or perirenal tissues.
3. X-ray examination of the spine in these cases gives little or no aid in making the diagnosis.
4. The possibility of this disease should be borne in mind in cases of suspected perinephritic abscess. In the event no pathology around the kidney is found, the operation should not be concluded until a thorough exploration is made of the lower dorsal and upper lumbar spine in the region of the kidney.
5. The operative procedure should consist of liberating the pus and gently curetting the involved bone.

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A METHOD OF INSERTING BLOOD TRANSFUSION NEEDLES INTO VEINS*

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I HAVE been asked many times by physicians what I considered the best method of introducing a needle into a quite a little pressure has to be used in order to force it through the skin. In doing this, both the anterior and the posterior

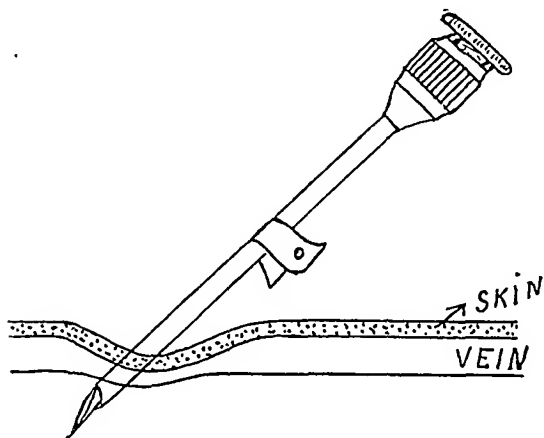


FIG. 1.

vein. The method I will describe has been used by me for the past five years, especially in doing blood transfusions.

Most men agree that the most important, and the most troublesome step in doing a blood transfusion is the insertion of the needles; the following method has given, and is giving me a great amount of comfort and success.

It must be recognized that inserting an ordinary hypodermic needle, which is usually about a 23 gauge, is quite a different problem from inserting a transfusion needle which is usually a 16 gauge.

The ordinary hypodermic needle, on account of its being so sharp, and small, can, as a rule, be inserted directly into a vein without making much pressure on the skin overlying it. This is especially true if the needle is inserted from a lateral position.

When using a larger needle such as that used in doing a blood transfusion,

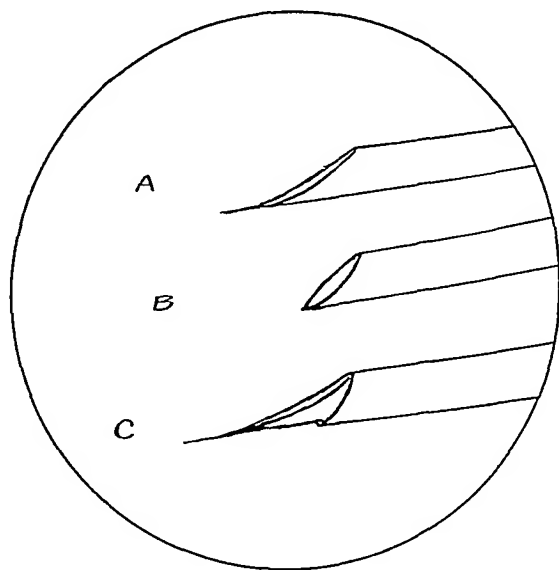


FIG. 2. (A) Inner cannula, or stylet. (B) Outer cannula. (C) Needle assembled.

walls of the vein are pushed together as seen in Figure 1.

It can be readily seen that it is almost impossible to put a large needle into a vein without piercing the wall on the opposite side; this, however, in my experience, has never been harmful.

A BLOOD TRANSFUSION NEEDLE

Let us consider for a moment the point of a blood transfusion needle. It is composed of an inner cannula, or stylet, which is very sharp and an outer cannula which is very dull. The point of the inner cannula, when in place, extends well beyond the point of the outer cannula and on account of its being very sharp cuts an opening

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through the skin and vein for the outer cannula to pass through (Fig. 2).

It is important that blood transfusion

Step 1: Hold vein that is to be punctured between thumb and index finger of left hand, or use a Silliman vein stabilizer to

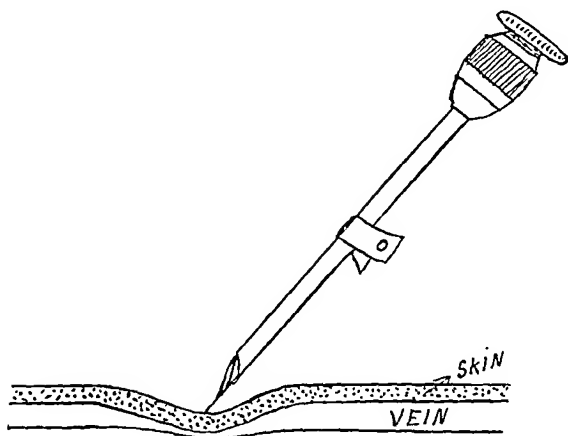


FIG. 3. Step 1.

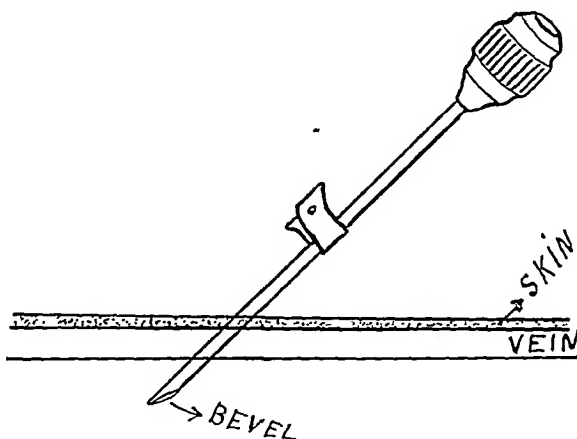


FIG. 4. Step 2.

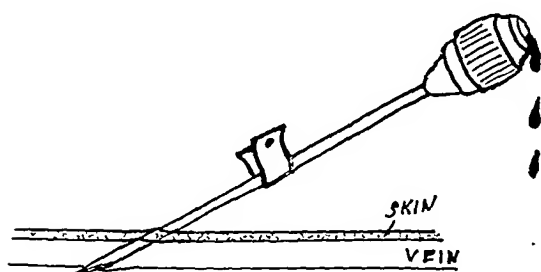


FIG. 5. Step 3.

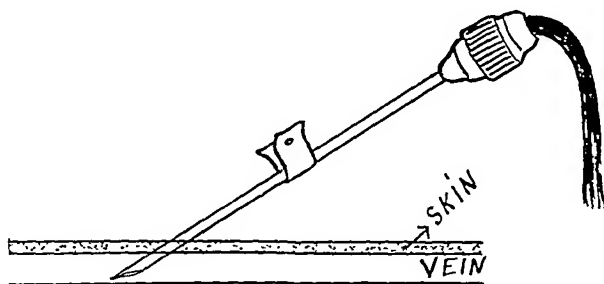


FIG. 6. Step 4.

needles be inspected carefully before use and the point on the inner cannula sharpened.

The most prominent vein at the bend of the elbow is usually selected as the ideal location for the puncture, the median cephalic or the median basilic being the veins most commonly used.

TECHNIQUE OF INSERTING THE NEEDLES

Place a tourniquet around the arm to the tightness of 60 mm. of mercury, and after the veins distend, inject a few drops of procaine 0.5 per cent in the skin at the site of the puncture.

A median size McNealey needle (16 G) is the one generally used and is always sharpened each time it is sterilized.

prevent vein from moving laterally. A McNealey needle is held in an oblique position in the right hand and pushed directly through skin and *middle* of vein, the needle passing through both walls of the vein as shown in Figure 3.

"It is essential to pass the needle directly through the middle of the vein; if not, trouble might be experienced later in trying to get the posterior wall of the vein to slip over the point of the outer cannula as the needle is slowly withdrawn."

Step 2: Remove sharp stylet and rotate needle so that the bevel points in the opposite direction as in Figure 4.

Step 3: Slowly withdraw needle and when the proximal edge of bevel rides into lumen of vein, blood will flow slowly from the needle as seen in Figure 5.

Step 4: The needle is then carefully withdrawn just a little further until the point lies wholly within the lumen of the

vein. If the point of the needle is not in the vein the salt solution will cause a swelling at the

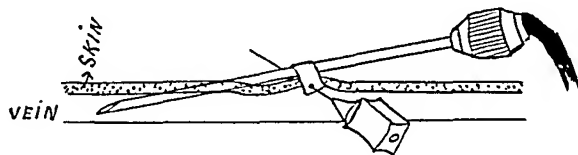


FIG. 7. Step 5.

vein. One usually feels the posterior wall of the vein snap over the tip of the needle, which is immediately followed by a free flow of blood from the needle (Fig. 6).

Step 5: Rotate the needle back to its original position and advance it into vein as far as it will go. Because the point is dull it will slide into the vein without any difficulty or without injuring the intima of the blood vessel; connect one of the rubber tubes from the syringe to this needle and then lock it to the skin by means of a fine hypodermic needle (25 G) (Fig. 7).

Step 6: Loosen the tourniquet that is around the arm and inject 10 c.c. of salt solution through needle that has just been inserted to make sure its point is resting

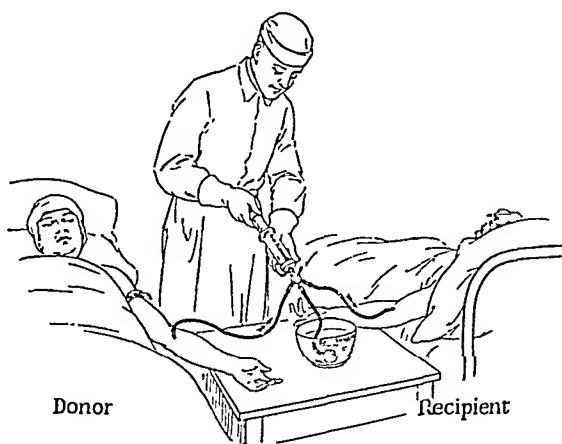


FIG. 8. Step 6.

site of the puncture, which can easily be seen (Fig. 8).

Never start a transfusion unless you are sure the points of the needles are resting completely within the walls of the veins of the donor and the recipient.

Always insert the needle into the donor first in order to avoid any possibility of infection being carried to him from the recipient.



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* Continued from p. 74.

SPINAL ANESTHESIA RECORDS*

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SURGEONS using and reporting upon spinal anesthesia frequently state that an experienced anesthetist should be observing the patient at the head of the

The very young and very old patients are variously considered by different writers on spinal anesthesia and differences in weight seem to call for different dosage.

Spinal Anesthesia Record

Dr.

Name	Age	Sex	Wt.	Date
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Operation

Preliminary Medication			Ephed.		Anes. and Am't					Volume of Dilution				Site of Injection		Position During Inj.	
Time Inj.	Time Est.	Operation Began		Ended	Position during Operation					Height of Anesthetic		Sensation Return		Motor Return			
Preop.		Start	5	10	15	20	25	30	40	50	60	70	80	90	100	110	120
B. P.																	
Pulse																	
Color																	

Additional anesthetics used:

Complications during and treatment:

Postoperative anesthetic complications:

Remarks:

operating table. Those who are beginning the use of spinal anesthesia are often confused by the various preliminary and other medications advocated and find it necessary to develop their own technique. In order to evaluate the results obtained from the different combinations of drugs and to afford a systematic guide to the observing anesthetist, the writer elaborated a record blank for the use of the anesthetists and for his guidance in developing a technique of spinal anesthesia for the various surgical procedures.

Preliminary medication receives considerable discussion and the use of drugs for support of blood pressure has aroused a controversy. The drug used intraspinally, its amount and its dilution can vary considerably and still be satisfactory during the various surgical procedures. The interspace used for the injection and whether the injection is made in the lying or sitting position seems to affect the height of anesthesia.

While recording the foregoing data the anesthetist becomes familiar with the drugs

* Submitted for publication April 4, 1931.

used and next records the time of injection and time of establishment of the anesthesia with the additional data concerning the anesthesia.

Although many surgeons do not record the blood pressure, it affords an excellent and useful method of observation of the patient and is essential to the experience of the anesthetist. We have called for blood pressure readings every five minutes during the first half hour because it is during this period that the danger signs appear most frequently.

Additional anesthetics must be in readiness when the operation becomes prolonged and the recording of these enables the

anesthetist and the surgeon to determine later which is most useful for the procedure at hand.

Complications do occur during operation and in the main are treated by the anesthetist whose experience is here most useful and necessary. Post-operative complications should also be recorded and efforts made to improve the technique so as to avoid them.

When surgeons keep a record of this type they are able to compare results of spinal anesthesia obtained for different procedures and improve their technique accordingly, and the anesthetist making the record soon becomes experienced.



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* Continued from p. 55.

HEALING OF CHRONIC DUODENAL ULCERS*

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AFTER Mann and Williamson¹² had successfully produced chronic peptic ulcers in experimental animals, they were able accurately to control the activity and described the method of healing. They observed that the process of healing begins with the subsiding of the inflammatory reaction around and in the base of the defect, and the sloughing off of the necrotic tissue on the surface of the base. The defect is then covered with a temporary protective layer of fibrin beneath which the actively proliferating connective tissue forms a vascular, cellular, fibroblastic bud which appears like a mushroom in the area of the defect. This granulation bud is extremely friable and is easily destroyed. As a single layer of flattened epithelium grows in from the edges of the defect it constricts the base of the granulation bud at the same time growth is extending up to and over it. A mucous membrane is formed by the proliferation of this layer of epithelium and by reduplication it is thrown into folds, which form villi. The glands which regenerate closely approach in appearance the glands in the mucosa of the surrounding duodenal or jejunal wall. As healing progresses the stalk of the granulation bud is progressively constricted, until it is finally pinched off and lost, and the regeneration of the mucosa continues until the defect is entirely covered. Mann¹¹ observed this course of events in experimental duodenal and jejunal ulcers which were protected and permitted to heal while they were still in an acute stage; he also observed it in chronic ulcers which were indurated and calloused. However, he does not believe that this is the only

method by which chronic calloused ulcer may heal.

Kennedy⁹ described a similar process of healing in an acute duodenal ulcer in the case of an infant in which signs of melena neonatorum developed the second day after birth and death occurred on the eighth day of life. Caylor described a granulation bud which was present in the base or under the protecting, overhanging borders in 25 of 30 gastric ulcers in man, which were healing at the time the ulcers were resected. Crohn, Weiskopf and Aschner⁴ also described this method of healing in chronic peptic ulcers.

Stewart¹⁵ described a method of healing of chronic peptic ulcers which was similar to that described by Bolton. He stated that necrotic tissue is an effective barrier to epithelialization and that a clean base is the prime requisite for the healing of chronic peptic ulcer. When healing begins the necrotic tissue in the base of the defect sloughs off and the underlying and surrounding inflammation subsides. A layer of epithelium then grows over the defect from the margin, and from it the mucosa is regenerated and eventually covers the defect. Stewart¹⁴ described the microscopic criteria of the scar of healed chronic peptic ulcer as definite and characteristic. Mann¹¹ described them in healed chronic duodenal and jejunal ulcers which he produced experimentally. There is fibrosis of the muscular coats in the area of the scar, which more or less completely replaces them, depending on the depth of the defect, which extends laterally beyond the defect. There is more or less fibrosis of the serosa, and endarteritis and endophlebitis of the blood vessels, even to obliteration of the

* Abridgment of thesis presented to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Medicine, June, 1931. Work done in the Section on Pathologic Anatomy, The Mayo Clinic.

lumen, which may or may not be recanalized. The regenerated mucosa which covers the defect rests directly on the

scopic descriptions of the scar of a healed chronic peptic ulcer.

A series of chronic duodenal ulcers,



FIG. 1. Beginning healing of a chronic duodenal ulcer ($\times 13$).



FIG. 2. Healing of a chronic penetrating duodenal ulcer ($\times 12$).

base of fibrous tissue, and the muscularis mucosae is not regenerated in this area. The connective tissue in the regenerated mucosa is increased, and the glands and the epithelium of the mucosa are atypical. Other observers have given similar micro-

which was observed at necropsy, was studied in microscopic sections for evidence of healing. The bud of granulation tissue, which Mann¹¹ and subsequently Kennedy, Caylor, Crohn, Weiskopf and Aschner,⁴ and others, described as occurring in a

healing peptic ulcer, was not observed in the sections of the ulcers in this series. Any one of several reasons would explain

ulcers the bud was destroyed at necropsy, due to handling, in spite of the care used to prevent it. The granulation bud was not



FIG. 3. Duodenal scar of a chronic ulcer ($\times 15$).

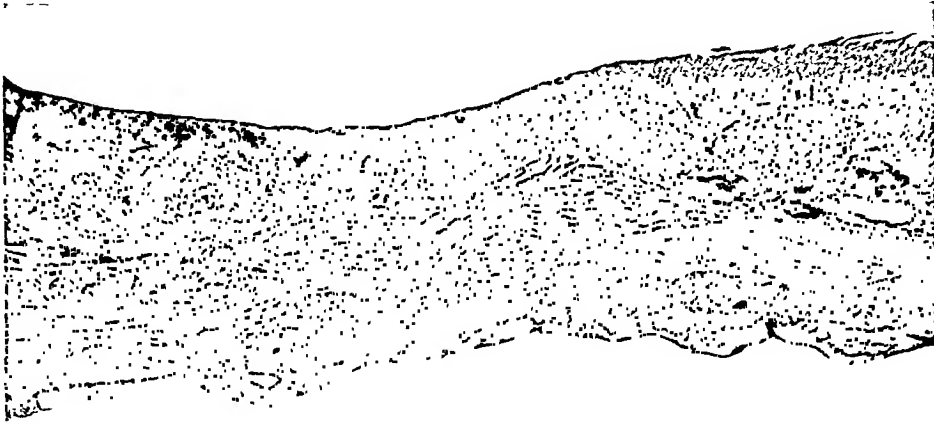


FIG. 4. Duodenal scar of a chronic ulcer ($\times 9$).

this. The granulation bud represents one phase of the healing process, and in some of the cases death occurred just prior to or subsequent to this phase. Mann¹¹ has emphasized the marked ease with which the granulation bud is destroyed, and since the duodenal ulcers in this series were not completely protected, in some of them the bud may have been destroyed prior to or at death. It is also possible that in some of the

seen in one of the ulcers in this series because healing was occurring without it.

Chronic duodenal ulcer which had ceased to progress and was beginning to heal when death occurred (Fig. 1) was found incidentally at necropsy in a man aged sixty-six years. The ulcer was on the posterior wall of the duodenum about 3 cm. from the pylorus. The microscopic section included the margin and slightly

more than half of the crater and was cut from the central portion of the ulcer. The crater of the ulcer was not deep and the margin was sloping, but there were definite pathologic changes which denoted chronicity. The base of the defect was composed of connective tissue which had almost totally replaced the muscle coats and extended wider than the limits of the defect. The serosa was thickened and there was endarteritis and endophlebitis of the blood vessels. A small-sized artery showing the pathologic changes of endarteritis, and an organizing thrombus were on the surface of the crater. At the margin of the defect the inflammatory process tapered off into the surrounding mucosa and submucosa. In this zone the glands were actively proliferating, and mitotic figures were seen with a higher magnification. A protective layer of fibrin covered the surface of the crater and indicated the earliest step in the healing of an ulcer after the necrotic tissue had sloughed off. There were still many lymphocytes and some polymorphonuclear leucocytes in the connective tissue base of the crater, the remains of the inflammatory process.

A chronic, penetrating duodenal ulcer, which was in an early stage of healing when death occurred was situated on the anterior wall of the duodenum of a man, aged forty-seven years. It had perforated sixty-five days before death. The perforation had been closed surgically twenty-two hours after its occurrence. The margin of the ulcer was undercut, and the base was composed of a thin layer of dense connective tissue which had entirely replaced the muscle coats. The central portion of the defect, which was quite large, had been reinforced at operation. Several layers of Lieberkühn's glands were growing from the margin toward the center of the defect. The glands were actively proliferating, and with higher magnification mitotic figures were seen. The glands lay horizontally, and on the surface one end of some of the glands was open and epithelium bridged the connective tissue between them, forming rudimentary

villi. A layer of flattened epithelial cells in the form of a syncytium covered the base of the crater nearer the central portion. There were no cellular remains of the inflammatory process in the base of the crater. Healing in this case was the result of proliferation of the mucosa at the margins directly on a clean fibrotic base, without the presence of a bud of granulation tissue. The dense avascular fibrous tissue in the base of this crater would not be a fertile source for a granulation bud. In this ulcer satisfactory and permanent healing would seem questionable.

A chronic penetrating healing duodenal ulcer which at the time of death was past the stage when a bud of granulation tissue might have been present (Fig. 2) was noted in the case of a man aged forty-four years, who died fifty-three days after gastroenterostomy had been done for the relief of symptoms of ulcer. The ulcer was situated on the posterior wall about 3 cm. from the pylorus. The microscopic sections were cut through the central portion of the crater and demonstrate the reduction in size that may result from the contraction of the fibrous tissue. The base of the crater consisted of a thin layer of connective tissue which had completely replaced the muscle coats and extended beyond the limits of the defect. Endophlebitis and endarteritis of the blood vessels, and thickening of the adventitia were noted. The newly forming mucosa which was covering the defect lay directly on the fibrous base, and was somewhat macerated before the tissue was fixed. It consisted of cellular connective tissue which was rich in blood capillaries and was covered by tall columnar epithelium.

The scar of a chronic duodenal ulcer (Fig. 3) which was situated on the anterior wall of the duodenum about 3 cm. from the pylorus was found incidentally at necropsy in a man aged thirty-nine years. The site of the ulcer was readily recognized. In that area fibrous tissue had completely replaced the muscular coats, and the serosa was slightly thickened. The mucosa, which

had covered the defect, rested directly on the thin connective tissue base, and the muscularis mucosae had been destroyed in this area. The regenerated mucosa contained a relatively larger proportion of connective tissue, and glands which were atypical. The contour of the duodenum in this section again indicated the effect of contraction of fibrous tissues in reducing the size of the defect.

The scar of another chronic duodenal ulcer (Fig. 4) was found incidentally at necropsy in a man aged forty-nine years. This scar was situated on the posterior wall of the duodenum about 3 cm. from the pylorus, and it might well be selected as the optimal end-result of healing of chronic duodenal ulcer. The ulcer appeared as though it might be permanently and thoroughly healed. The site of the ulcer was readily recognized by the fibrosis which had replaced the muscular coats, by the thickening of the serosa, by the endarteritis and endophlebitis of the blood vessels in the serosa, and by the absence of the muscularis mucosae. The mucosa at the site of the defect contained more connective tissue than was present in the mucosa and submucosa adjacent to it, and in the newly-formed mucosa the glands closely resembled and yet differed from the glands in the mucosa and submucosa adjacent to it.

Many experimental workers have shown that healing begins almost coincidentally with the formation of acute peptic ulcer. There is active proliferation of the connective tissue, of the glands, and of the epithelium at the margin of the defect in an attempt to heal it. Kennedy described such evidence in an acute duodenal ulcer occurring in an infant. If the factors which are producing the ulcer, whatever they may be, hold the balance of power over the attempts of the duodenum or stomach to heal the ulcer, the ulcer will progress and in the course of time it will show evidence of chronicity. Deaver and Reimann, Stewart,¹⁵ Connor, Hurst, Levine, Horsley and many others believe that

chronic peptic ulcer is an acute ulcer which has persisted in an unhealed state. As a chronic ulcer progresses there is continued connective tissue proliferation in an attempt to limit its extent as well as to prevent its perforation. It is undoubtedly true that the balance of power alternates between progression and healing, so that a chronic ulcer will begin to heal and then will become reactivated repeatedly. Crohn, Weiskopf and Aschner^{4,5} have found that ulcers which are resected during the time the patient is free of symptoms show evidence of healing, whereas ulcers that are resected when the patients are having symptoms show evidence of progression. It has been the experience of Deaver and Reimann, however, that every chronic ulcer shows evidence of exacerbation and progression regardless of whether the patient is having symptoms. They expressed the belief that chronic ulcers will, and do, heal but they have never encountered such as ulcer.

Microscopic sections of chronic indurated and calloused peptic ulcers with dense fibrous-tissue base and margins and obliterated blood vessels, clearly show how difficult it is for them to heal with any degree of permanency. However, when they do heal, many factors aid in the process. The contraction of the fibrous tissue helps to reduce the size of the defect. The inflammatory process in the margins subsides, and they become flattened and are drawn closer to the base. The inflammation in the base subsides and the necrotic tissue sloughs off so that this barrier to epithelialization is removed. The degree of proliferation of connective tissue in the base during healing depends on its type. If the base is dense fibrous tissue with few blood capillaries, it probably will not form a fibroblastic bud. If, however, it is not dense and does contain a reasonable number of blood capillaries, it will undoubtedly proliferate to form a fibroblastic bud, such as Mann¹¹ and Caylor have described. The glands and the epithelium at the margin of the crater will show more

active evidence of proliferation, with many mitotic nuclei, in an attempt to reduce the size of the defect and to cover it with epithelium either with or without the aid of a granulation tissue scaffold. These various factors will result in complete healing of a chronic ulcer with the formation of a scar if the ulcer is not reactivated. The microscopic criteria of the scar of a healed chronic ulcer, which have been so clearly described by Stewart,¹⁴ will remain. This microscopic evidence should be correlated with the gross appearance of the scar and the secondary changes in the duodenum. Robertson and Hargis described the changes in the duodenum which are secondary to chronic duodenal ulcer. They include shortening to less than the normal average of the distance between the pylorus and the ampulla of Vater, the

formation of pouches in the duodenal wall adjacent to the ulcer or the scar, and the distortion of the duodenum.

SUMMARY

The microscopic appearance of some of the phases which occur in the healing of chronic duodenal ulcer as observed at necropsy is presented.

The various factors which aid in the healing of chronic duodenal ulcer, with the exception of the formation of the granulation bud described by Mann, are illustrated in microscopic sections.

The microscopic criteria of the scar of chronic duodenal ulcer as described by Stewart are illustrated.

The part which the glands of Lieberkühn may play in the healing of chronic duodenal ulcer is illustrated in microscopic sections.

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ADENOCARCINOMA OF THE SIGMOID WITH METASTASIS TO THE EYE*

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A WOMAN, aged forty-eight years, registered at The Mayo Clinic November 11, 1930, because of diarrhea and constipation. In September, 1929, rather severe diarrhea had developed; evacuations of the bowel numbered as many as 25 and 30 a day and the stools were soft. Since the spring of 1928 occasional traces of blood had been noticed in the stools. During the year of 1929 at irregular intervals as much as 200 to 300 c.c. of blood and mucus was passed at one time. In the last few months before registration constipation had been marked. Several days would elapse without a bowel movement. In July, 1930, hemorrhoidectomy had been performed elsewhere. About the same time proctoscopic examination showed a few "raw" areas in the rectum and roentgenologic studies of the colon revealed what was interpreted by the patient's local physician as a filling defect in the splenic flexure of the colon. There had been practically no loss of weight. For eight weeks slight pain had been present in the left sacroiliac region and also a rather annoying dull pain in the left eye, the vision of which was blurred at times. There was some soreness occasionally noticed on movement of the eye which the patient described as a raw feeling. At times recently she had noticed an uncomfortable sensation in the rectum and feared malignancy.

General examination disclosed some fullness in the left iliac region which was thought to be dilatation of the colon. The results of pelvic and rectal examinations were negative. Movements of the spine were good. The systolic blood pressure was 110, the diastolic 70; the pulse was 80 and the temperature was normal. The Wassermann reaction of the blood was negative. Examination of the urine, except for an occasional pus cell, was negative. The hemoglobin was 10.5 gm. in each 100 c.c. of blood; erythrocytes numbered 4,560,000 and leucocytes 9000. Examination of the eyes, October 13, showed vision of the right eye $\frac{9}{4}$ and of the left eye $\frac{9}{5}$. The pupils were irregu-

lar but the reflexes to light and convergence were normal. The field of vision of the left eye showed a defect in the upper temporal quadrant. There was edema of the disk and detachment of the retina in the lower nasal quadrant with considerable choroidal disturbance. Subsequent examination showed that there was a flat mass behind the retina spreading over the posterior part of the fundus which was apparently more than 1 cm. in diameter. Furthermore, vision was reduced to ability to distinguish moving objects. The tension was high and the eye was painful. Roentgenogram of the thorax showed a globular, intrapulmonary mass at the level of the fifth rib which was thought to be metastatic. Proctoscopic examination showed an annular carcinoma involving the upper end of the rectum, causing moderate obstruction. A specimen for diagnosis was removed and showed adenocarcinoma, graded 1.

Because of the patient's excellent physical condition exploration was advised, and was carried out November 17, 1930. The liver and aortic lymph nodes felt free from metastasis. There was a small annular carcinoma just above the pelvic peritoneal fold. The growth was freely movable and was operable. Left inguinal colostomy was made, and the question of resection of the rectosigmoid was left to be considered later.

The postoperative convalescence following the colostomy was without incident except that about a week after the operation attacks of severe pain occurred in the left eye. The vision failed rapidly. The sclera became markedly injected. Removal of the eye was advised, and was carried out December 1, 1930. The conjunctiva was closed, and the wound healed without incident. Without knowledge of the lesion in the colon the pathologist made the diagnosis of metastatic adenocarcinoma of the eye, evidently secondary to a lesion in the colon. The report was as follows:

Microscopic sections showed that a tumor about 3 mm. thick occupied the posterior

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third of the eye, and surrounded the optic disk more on the temporal than on the nasal side. The retina was detached especially on the

was within the eye and none was outside the cribriform plate (Figs. 1 and 2).

This case is reported because of its

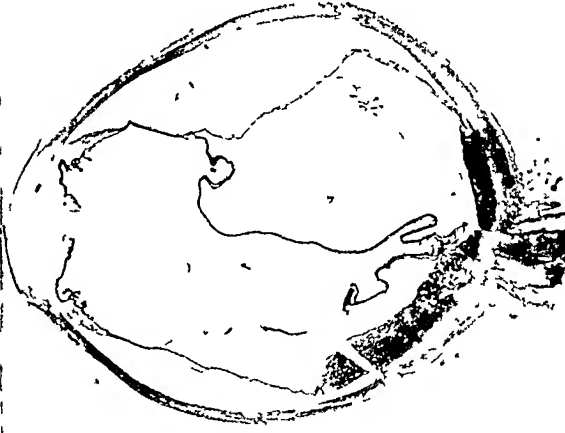


FIG. 1. Flat layer of carcinomatous tissue between detached retina and sclera. It covers optic disk but does not penetrate cribriform plate or invade optic nerve (hematoxylin and eosin stain $\times 2\frac{1}{2}$).

nasal half and an accumulated mass of homogeneous eosin-staining exudate filled the area between the retina and the choroid. The tumor was situated between the choroid and the sclera and was covered by the pigment cells of the choroid. The tumor stained deeply with hematoxylin and was made up of a high columnar type of epithelium characteristic of carcinoma of the colon. The cells arranged themselves in irregular acini. The carcinoma cells had hyperchromatic nuclei, the cell cytoplasm was sparse and mitotic figures were numerous. Mucicarmin stains showed mucous masses in the centers of the acini but few mucous droplets were seen in the epithelial cells. This was further evidence that the growth was highly malignant. The carcinomatous invasion had evidently reached the eye by the blood stream and yet none of the blood vessels of the retina, the choroid, sclera or optic nerve contained tumor cells. The space between the optic nerve and its sheath also was free from carcinoma, and all of the tumor



FIG. 2. Type of carcinoma usually found in colon. Acini are irregular, nuclei hyperchromatic, and many mitotic figures are present. Most of the acini contain mucus but no droplets of mucus are present in the cells. Pigment-containing cells of choroid covering mass may be noted (mucicarmin stain $\times 100$).

extreme rarity. It demonstrates the unique and bizarre fashion in which lesions of the colon may metastasize. The patient at the present time is ambulatory. She has considerable intermittent pain in the left sacroiliac region. In spite of the negative roentgen-ray examination of this region it seems logical to assume that the sacroiliac pain is due to metastasis. The intrapulmonary mass, which was observed roentgenologically, is probably also metastatic.

TRAUMATIC RUPTURE OF THE STOMACH

REPORT OF TWO CASES*

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TWO cases have in a large measure furnished the basis for the title here. Their case records will be used as a brief introduction and discussion of a relatively uncommon acute surgical condition. Perforated ulcers and such injuries as gunshot wounds, malignancies, or other direct perforations, are excluded from this discussion.

CASE 1. J. B., No. 4811, Highland Hospital, Oakland, Calif. J. B., aged thirty-one, male, stone-mason by occupation, gave a history of having been struck by a rapidly moving automobile as he stepped from his own automobile. He was thrown about 20 ft. and landed in somewhat of a sitting posture. He gave a history of having had a very heavy evening meal just prior to the accident. He was transferred from the site of the accident, which was approximately two miles, immediately after the accident, to the Emergency Department of Highland Hospital. There was no previous history of any importance, either of a medical or surgical nature. Patient stated that he had always enjoyed excellent health.

Physical Examination: Upon admission to the Emergency Department of Highland Hospital, the patient was in shock, with a pale, moist, clammy skin but conscious. His pulse was about 140 and regular. His temperature was normal. There were many superficial abrasions, lacerations, and contusions noted about the head, neck, arms, legs and chest. It was noted that at least five ribs were fractured on the right side, the site of the fracture being at the anterior axillary line. A diagnosis was made of a hemothorax on the left side. The abdomen showed no superficial marks or evidence of injury. However, the musculature over the left side of the abdomen was markedly rigid. Liver dullness was not obliterated. There was also noted a comminuted fracture of the left tibia and fibula. The internes in the emergency room thought that the muscle rigidity noted over the left side of the abdomen was due to

the severe trauma over the left side of the chest. The patient was accordingly put to bed, was given a 0.3 gm. ($\frac{1}{2}$ grain) dose of morphine sulphate and treated generally for shock. After an hour or so, the pulse dropped to 112 per minute, and his general condition seemed much improved. However, four hours after admission, the pulse again became more rapid and the abdominal tenderness and muscle spasticity became more generalized. The patient at this time presented the type of abdomen so frequently found in conditions such as perforated gastroduodenal ulcer and acute pancreatitis.

Four and a half hours after the patient was admitted to the hospital, a diagnosis of ruptured viscus having been made, he was taken to the operating room and the abdomen explored (operated on by the writers). Under a light gas-ether anesthesia, the abdomen was opened by a high right rectus incision. Immediately upon opening the peritoneal cavity, some whitish, bloody fluid was noted to exude through the small nick in the peritoneum. Also gas bubbles were noted bubbling through the small hole in the peritoneum. Further exploration of the peritoneal cavity and its contents disclosed a large boggy mass in the upper left quadrant. This was at first thought to be a ruptured spleen, but further examination disclosed the fact that the mass was in the lesser omental space and that the spleen was entirely normal. The lesser omental cavity was investigated by approach through the transverse mesocolon as in doing a posterior gastroenterostomy. Upon opening the lesser peritoneal cavity, there was noted perhaps a pint of semi-digested food, blood clots and apple peels. Inspection of the stomach showed an irregular rent which involved the entire stomach wall from a point on the posterior surface of the stomach from a point near the cardia downward for a distance of 5 cm. This rent in the stomach was closed by a series of interrupted Lembert sutures. Further exploration of the abdominal cavity was done, and none of the organs were found to have been injured. The abdomen was closed in the routine fashion without drainage.

* Submitted for publication March 18, 1931.

The patient's condition while in the surgery was very stormy and while in the surgery he was given 1000 c.c. of 2 per cent glucose solution and a 2 decigram (0.2 gm.) dose of caffeine. After he was returned to his bed his condition did not improve, and he expired twenty-four hours after leaving the surgery. The necropsy was very incomplete, due to family objections, and no additional injuries were found.

CASE II.* A. L., Merritt Hospital, No. 11597. A. L., aged twenty-nine, employed as a truck driver. Admitted to Merritt Hospital on June 10, 1928, at about 12 M. He was dismissed from Merritt Hospital on August 12, 1928.

Chief Complaint: Severe pain over the abdomen, associated with nausea and vomiting. "I have vomited so much blood that I am weak."

Past History: Patient has always enjoyed good health, except for a long standing history of sore throats which have occasionally been complicated by rheumatism involving the joints of both feet. Gonorrheal infection ten years ago. He denies syphilis. Married, wife living and well. Has lived in California most of his life, and for the past ten years has been employed as a truck driver.

Present Illness: Began about 10:30 A.M. at which time patient was thrown very forcibly against the steering wheel of his truck. Immediately after the accident patient experienced great pain, which was knife-like in character, over the entire abdomen. He became cold and his skin and clothing were wet with perspiration. Patient states that about one-half hour before the accident he had consumed two very large malted milks, which he estimates as being about 2 quarts in quantity. The material vomited consisted of partially digested malted milk and blood, patient stating that vomiting greatly relieved his pains. Shortly after the accident patient was moved from the site of the accident by ambulance to his home, where one of us (C. R. F.) saw him a few minutes after his arrival. Upon inspection and a hurried physical examination, it was observed that the patient was desperately ill and should be immediately hospitalized.

Physical Examination: Merritt Hospital, about one and one-half hours after the accident.

* It is with the courtesy and permission of Dr. C. A. Dukes, Chief Surgeon of the Division, that this case is presented.

Inspection showed a young man approximately thirty years of age, is writhing with pain, retching and occasionally vomiting. The vomitus consists of partially digested food which was streaked with blood. The skin and its appendages were entirely normal except for a clammy perspiration which covered the entire body. Head and neck entirely normal, except for the presence of hypertrophied, cryptic tonsils. Chest is well formed, musculature is good. Heart, pulse about 110 per minute, quality of pulse being soft and slightly irregular. Blood pressure 90/50 mm. Hg. There are no murmurs. Heart sounds are soft in quality. $A^2 = P^2$. A.C.D. not enlarged. Lung expansion is equal. Breath sounds vesicular over the entire lung area. There are no râles heard. **Abdomen:** Inspection shows the abdomen to be somewhat distended. There is noted a reddened, contused area over the power portion of the sternum, also over the left umbilical region, patient stating that this is where he was struck by the steering wheel of the truck. Palpation of the abdomen is exquisitely painful. There is marked spasticity of the entire abdominal musculature which is decidedly board-like. There are no masses or tortuosities noted anywhere over the abdomen. Rectal examination is entirely normal. Reflexes and extremities are normal except for a markedly contused and abraded area over the anterior surface of the right tibia. Patient states this condition was caused by his being thrown against the instrument board of his machine.

A tentative diagnosis was made of a ruptured viscus. It was thought that this diagnosis might be further clarified quickly by taking a flat x-ray picture of the abdomen. This was accordingly done by utilizing a portable x-ray apparatus which is used on the floor for fracture work. Upon examination of the film there was clearly shown a considerable amount of air above the liver, proving conclusively that there was a ruptured viscus and that this viscus must be the gastrointestinal tract. Patient was taken quickly to the surgery where, under gas-ether anesthesia, the abdomen was opened by a high right rectus incision. Upon opening the peritoneal cavity there was noted a gush of bloody, partially digested food, mainly consisting of milk curds. The stomach was identified and over the anterior pyloric area there was noted a rent about $2\frac{1}{2}$ cm. in length. The edges of the lacerated stomach were still bleeding

quite profusely. The rent in the stomach was quickly closed by a series of interrupted Lembert sutures. The abdomen was closed in the routine fashion without drainage. The time elapsing from the time of the accident to the completion of the operation was approximately three hours.

Patient's convalescence while in the hospital was very stormy for the first ten days, but following this time he made an uneventful recovery, being discharged on August 12, 1928, sixty-two days after his admission, his prolonged stay in the hospital being mainly due to a rather virulent wound infection which was treated by Dakin solution irrigations.

Patient has been seen by one of us (C. R. F.) at his private office at irregular intervals since his discharge from the hospital and he is now apparently enjoying good health.

After considerable search of the literature, the writers were impressed with the comparative rarity of the condition of traumatic rupture of the stomach as compared to other organs. This is undoubtedly due to many factors. For example, the stomach is comparatively well protected by surrounding structures, viz., liver, spleen and thoracic bony structure. The stomach does not lend itself readily to being ruptured. The musculature of the stomach wall is relatively thick and is arranged in an interlacing fashion so as to withstand trauma.

We are also impressed by the fact that the slightest trauma might produce extensive gastric lesions.* Makin in 1870 reviewed 282 cases of abdominal injuries 8 of which had to do with a rupture of the stomach. Petry in 1896 reported 219 cases of rupture of the gastrointestinal tract and found only 8 cases of traumatic rupture of the stomach. There have been recorded in the literature rather exhaustive compilations of case reports regarding the various degrees and types of gastric rupture and the causes therefor, but we are only concerned with that type of gastric rupture in which there is a complete severance of the stomach wall, permitting the escape of the gastric contents into the peritoneal cavity.

* *Brit. M. J.*, 2: 185, 1870.

We were impressed by the high mortality rate in cases of traumatic complete rupture of the stomach. For example, Andrew in 1894 reported 12 cases, all of which were fatal, most of the patients dying shortly after leaving the surgery, others living from two to five days. Deaver and Ashurst of Philadelphia, report 4 cases; all of these patients died soon after surgery. Scotson reports 2 cases of traumatic rupture of the stomach. The patients were operated on eight hours after the accident and both recovered. Bolton also reports a case in which the operation was performed shortly after the accident, with a complete recovery to his patient.

Perhaps the most complete discussion on the subject of gastric rupture (traumatic) is that by Glassman, who reports 31 cases of traumatic gastric rupture, 65.6 per cent showing other injuries, mostly internal. Twenty-two per cent had associated injuries to the spleen and 18.77 per cent had injuries to the liver. This report of injuries to other organs as associated with traumatic injuries to the stomach is similar to the findings of others.

The high mortality in this type of case is due to many factors, viz., the severe trauma, shock, hemorrhage, and peritonitis which is most important and probably is directly proportional to the delay between the time of the injury and the time of surgery. This fact was borne out in our own small number of cases. The site of the perforation in the stomach varies and may be found anywhere in the organ. However, most of those who have investigated this type of injury have found that fully two-thirds of the rents in the stomach wall have been found in the pyloric region. This is perhaps explained by the following facts: The stomach is more exposed here. It is comparatively fixed and directly in front of the spinal column. The cause of stomach rupture is variously explained but the question of distension is undoubtedly the chief factor, plus the trauma. Both of our patients had full stomachs at the time of the accident.

CONCLUSION

1. Rupture of the stomach is uncommon as compared to other ruptured viscera. Its symptoms are rather constant, vomiting and hematemesis occurring in most cases, and shock and an acute abdominal storm of most terrific and dramatic character. Patients are frequently moribund before the condition is diagnosed.

2. Once the condition is diagnosed,

laparotomy is the only treatment, recovery being directly in proportion to the lapse of time between the accident and surgery. The x-ray is invaluable as a diagnostic aid in this type of case as was demonstrated in Case 11 of our own.

3. Both of our cases were the results of automobile accidents, and due to the increase in number of automobile accidents this condition may be looked for with greater frequency.

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TREATMENT OF CERTAIN CASES OF DUODENAL ULCER BY JEJUNOSTOMY

WITH THE APPLICATION OF SOME OF THE NEWER PHYSIOLOGICAL PRINCIPLES
AND USE OF AN ELECTRIC FEEDING PUMP*

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THE cause of peptic ulcer is still undetermined. We know that rest, elimination of pylorospasm, lowering of acids and lessening of emptying-time are important factors in the healing of ulcer.

Before discussing the treatment of ulcer by jejunostomy we would like to evaluate briefly the recognized treatments of today:

A. *Medical treatment* cures or greatly benefits many cases, particularly those of shorter duration. If the economic condition permits, many chronic cases can be kept comfortable as long as medical treatment is strictly adhered to. But there is a considerable number of comparatively younger men who have had several courses of medical treatment without relief, and who because of economic stress are asking for a cure. It is this type of case in which we are particularly interested.

Since duodenal ulcers are located in zones of great motor activity and high acidity, healing must be delayed unless this motor activity and excessive acidity is inhibited. It is doubtful whether medical treatment with its frequent feedings puts this active mechanism at rest, nor does it prevent contact and passage of gastric contents over an inflamed or ulcerated area. Medical treatment has a further disadvantage in that it does not eliminate concomitant disease, such as the infected gall bladder or appendix.

B. *Gastroenterostomy*. No one will dispute the satisfactory results that follow this operation when performed in a man usually beyond the forties, who has had a chronic sclerosing ulcer associated with considerable organic obstruction. The popularity that this operation gained years ago

is based on the results obtained in this type of case. Since duodenal ulcers are being recognized earlier and oftener by the profession, another type of case presents itself. It is this type, occurring in comparatively younger men, who develop as the result of pylorospasm, a hyperacidity and hyperperistalsis, and who after a gastroenterostomy, frequently have marginal and jejunal ulcers, as well as inflammatory processes and mechanical derangements at the stoma.

C. *Pyloroplasty*. Excision of the ulcer with a plastic operation on the sphincter mechanism to hasten the neutralization of the acid contents, has been used by many surgeons to supplant gastroenterostomy for the type of cases mentioned in the preceding paragraph. The operation has many limitations, however, the most important of which are:

(a) Ulcers often are not conveniently situated for excision.

(b) Mobilization of duodenum and pylorus is often difficult or impossible.

(c) Duodenal ulcers are frequently multiple, often occurring on the posterior wall.

(d) Duodenitis, with or without ulceration, is common and it is often impossible of complete excision.

(e) Posterior ulcers are frequently multiple and are usually surrounded by an edematous, inflamed zone. They are usually treated by excision with a cautery. Closure of the burned area by introduction of chromic stitches from the mucosal side and through tissues which are frequently inflamed, followed in a few days by the motor activity of digestion, does not particularly appeal to us.

* Submitted for publication April 10, 1931.

(f) Scarring of the impaired pyloric mechanism and adhesions around this area are usually pronounced, and may be a cause of postoperative symptoms.

(g) Ulcer frequently recurs at or near the suture-line.

(h) Clinical results do not appear to be as satisfactory as after gastroenterostomy.

D. *Gastrectomy*. Resection of 60 per cent of the stomach for benign duodenal ulcer whose crater is rarely greater than 1 cm. in diameter, is a radical procedure. Even though this operation usually assures a more rapid emptying time and is productive of an-acidity or hypo-acidity, it does not eliminate the possibility of gastrojejunal ulcer forming years afterwards. In the hands of the average surgeon it has a prohibitive mortality.

JEJUNOSTOMY

Jejunostomy has been used for years in the treatment of various gastric lesions, and a review of the literature impresses us with the fact that jejunostomy is being used in the treatment of extensive inoperable ulcers of the stomach. It has been suggested and even tried as a routine measure in the treatment of peptic ulcer. We noted furthermore that these cases were usually fed by means of a funnel and that abdominal distress and loss in strength commonly resulted. No attempt was made in these cases to reduce the acids to a minimum by eliminating the cephalic and jejunal phases of gastric secretion, nor were hunger contractions eliminated by this means of feeding. This is probably one reason why this procedure has not become more popular. The literature is replete with reference to cases where jejunostomy had actually healed extensive gastric ulcers despite the fact that no application of newer principles in gastric physiology had been made.

If it is true as Ivy says that "the associated augmented motility renders it difficult for the mucosal cells to obtain a foothold on the base of the ulcer and to establish relation with the underlying

capillaries which is their source of nourishment, then that procedure which allows most physiologic rest should play an important part in the healing of ulcer." Jejunostomy permits physiological rest.

To quote Ivy further: "factors which tend to disturb the blood supply or nutrition of the proliferating mucosal cells are responsible for delaying healing." Food or acid chyme as an irritating factor is eliminated by jejunostomy; and by eliminating most of the gastric, cephalic and intestinal phases of gastric secretion, acids are reduced to a minimum. The motor drive of the stomach and pylorospasm are inhibited, and duodenitis is most likely benefited by the physiologic rest.

We believe, with Ivy, that an ulcer treated by the greatest amount of physiologic rest and with the least amount of irritation from acid, food and motor drive, will result in better healing, with less formation of scar tissue and more substantial mucosal covering and with possibly less likelihood of recurrence or reactivation. Jejunostomy it seems to us meets these indications.

Gastric juices are reduced by the absence of food in the stomach. The psychic secretions and contractions are reduced or eliminated by keeping these patients in a private room away from the sight or smell of food. We usually place cotton in the patient's ears and ask all attendants to refrain from the discussion of food. The intestinal phase of gastric secretion is reduced to a minimum by feeding these patients continuously and by introducing the jejunal tube into the gut for a distance of about 9 in. Ivy and others have shown in dogs with a gastric pouch, that gastric secretion from the pouch ceases during jejunal feedings of one hour's duration.

We use an electric feeding pump which ejects the mixture into the jejunum similarly to the spurts of chyme from the duodenum. By means of continuous feedings, hunger contractions are eliminated and patients experience no disagreeable abdominal sensations. Furthermore patients gain appreciably in weight. Until

recently we have used pancreatinized milk and fruit juices in the feedings. We are now using a formula used by Ivy for his jejunal-fistula dogs and recommended by him for human cases. It is a bland, non-irritating mixture containing enough calories and the proper proportion of proteins, carbohydrates, fats, vitamins, minerals and water.

This mixture consists of cane sugar, peptone, wheat flour, milk and cream. In addition Ivy recommends introducing cod-liver oil emulsified with bile, neutralized tomato juice, and viosterol.

The operation that we have performed is of the Witzel type, using a small, soft, pure gum-rubber tube. We wrap omentum around the insertion of the tube into the gut and suspend the gut by using this omentum as a hammock. When feedings are started it is important to keep the tube perpendicular to the abdomen or intestinal juices are likely to back up into it. We would also like to caution about giving the feedings very slowly.

We have used this method in 24 cases during the past ten months. All these patients had had considerable medical management and none showed evidences of pyloric stenosis or the possibility of developing a stenosis later. Our immediate results have been most encouraging, the patients experienced relief from pain and distress, blood disappeared from the stools and after going back to normal feeding by mouth their acids as determined by the fractional method showed marked reduction. In our earlier cases, before we had mastered the feeding problem, the loss of weight was rather marked. The patient remains in bed for two weeks, following which he is allowed to be up. The feedings in the day-time are then given at intervals, but the feedings at night remain continuous until the tube is removed. We usually remove the tube in from four to five weeks and the resulting fistulous tract closes in a few days. Although all of our patients stated that pain and distress disappeared almost immediately after instituting treat-

ment, we have felt that atropine is indicated in order to check the basal secretion (secretion of a weakly acid juice due to a

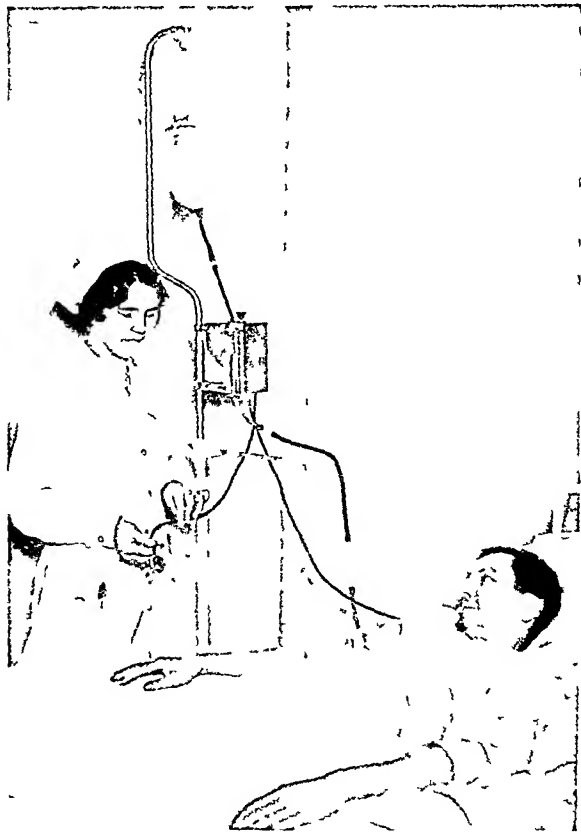


FIG. 1. Electrically driven jejunal feeding pump devised by one of my patients who underwent jejunal treatment for a bleeding duodenal ulcer.

We found early in our experience with jejunal feeding that the simple gravity method of administering continuous feedings was not satisfactory, in that the heavy Ivy mixture would not flow with any regularity, and as a result the patients complained of distress. This pump ejects the Ivy mixture into the jejunum in a manner similar to the normal discharge of chyme from the duodenum into the jejunum.

Since using this pump our patients have not complained in the least about distress; we were able to administer continuous feedings day and night and at no time did any of the patients have the slightest signs of hunger. We consider the elimination of the powerful hunger contractions a very important part of the treatment. We have also found that if the Ivy mixture is diluted with equal parts of water, our results are extremely satisfactory. The patients, all of them, have gained in weight. One of our inoperable cancers of the stomach gained over 30 lbs. in weight over a period of a few months.

hormone) as well as to aid in overcoming the pylorospasm and hypermotility.

Since we are not convinced that pylorospasm is a causative factor in the produc-

tion of an ulcer, but think rather that it is the result of an ulcer, we have not done any operation on the pyloric mechanism in conjunction with the jejunostomy. If recurrences were not so common following the various operations designed to eliminate the pyloric factor, we would be inclined to suggest some simple procedure to cripple the pylorus as an added part of our treatment of jejunostomy.

We have used jejunostomy in bleeding ulcers, as well as in the acute perforating type. In the case of bleeding ulcer with massive hemorrhages we would suggest transfixing the gastroduodenal artery, in addition to putting the part at rest with a jejunostomy.

Of course it is too early to make any assertions as to results, but we do know that we have preserved physiologic function, that we have had no mortality, and that gastrojejunal ulcers are not going to form later.

Until the cause of ulcer is definitely known we are willing to suggest various things in the way of after-treatment of these cases, which may or may not have a bearing on recurrence. All patients are instructed that they must live on a bland diet for years to come, that tobacco and alcohol are to be avoided, and that any bad eating habits should be corrected. A careful search is made for foci of infection. (These should be removed before treatment is started.) The patient is told that worry, anxiety and "high tension" existence are detrimental. In all of the cases we removed the appendix and in 6 cases we removed a diseased gall bladder as well.

We are not going to report on any of the patients operated on the past ten months because they are too recent to draw any conclusions from, but we are going to review briefly a case of a patient operated on in 1922.

This was the case of an adult male, aged twenty-eight years, who for two years previous to operation had been under medical management for a duodenal ulcer and who because of

economic stress requested operation for relief. He was operated at Columbia Hospital on Aug. 10, 1922, and a crater ulcer was found in the first portion of the duodenum. The inflammatory reaction and adhesions were so pronounced everywhere that we found it impossible to do a posterior gastro enterostomy. It was decided to do a palliative jejunostomy and it was intended to have patient return later for Billroth No. 1 operation. He was fed by means of tube and funnel for three weeks. His improvement was marked and to our surprise his symptoms never recurred. He was examined by us on February 2, 1931. X-ray showed an irregular cap probably due to adhesions. There was no six-hour retention. Patient stated that he had been perfectly well since 1922 and that he was able to eat everything.

We have treated several cases of inoperable carcinoma of the stomach by means of jejunal feedings. One patient gained over 30 pounds in a few months and was free from practically all subjective symptoms until a few days before his death, which occurred nine months after feedings had been instituted.

SUMMARY

1. Since feeding via jejunostomy places the stomach and duodenum more nearly at physiological rest for a longer period of time than any other known therapeutic procedure for gastric and duodenal ulcer, and since jejunostomy is a relatively simple surgical procedure that does not interfere with normal physiology, provided proper care is exercised in jejunal feeding, we believe that this method should be given a thorough trial.

2. In order to produce rest to the stomach and duodenum, certain physiological principles must be borne in mind: First, the powerful hunger contractions are eliminated by continuous twenty-four hour feedings with an electric feeding pump. The Ivy mixture, diluted, is most satisfactory. Secondly, acid is reduced to a minimum by eliminating the cephalic, gastric, jejunal and hormonal phases of acid secretion.

GASTROCHOLECYSTIC FISTULA

CASE REPORT*

J. O. RANKIN, M.D., F.A.C.S.

WHEELING, W. VA.

FISTULAE between the gall bladder and the duodenum or colon are not unusual. Such lesions are frequently seen as the result of cholelithiasis and cholecystitis, a stone ulcerating its way through the wall of the gall bladder into the intestinal tract and establishing a fistulous tract. A large stone may be passed out of the gall bladder in this manner and be the cause of acute intestinal obstruction. In a review of the literature of the last ten years, no reference was found to gastrocholecystic fistula. Such a lesion is mentioned as a possibility in a few of the standard textbooks of surgery. In view of the correct preoperative diagnosis and the successful surgical treatment of this rare lesion, we feel that this case report is fully justified.

Mrs. R. T., fifty-six years of age, presented herself for examination on May 10, 1930. She was examined by Dr. H. R. Sauder of the Medical Staff and the following history and physical findings are abstracted from his records. Her complaint was stomach trouble, consisting chiefly of dull aching pain in the right upper quadrant and gaseous distention coming on after her meals. Thirty years prior to the time of her examination she had had severe typhoid fever. Following her recovery from this illness she complained of severe cramp-like pains in the right upper quadrant. Her physician made a diagnosis of gastric ulcer. This pain usually came on one to two hours after eating and was intermittent in character. Her symptoms at that time continued for a period of eight years. Twenty-two years before the present examination, the patient was seized by very severe paroxysmal, cramp-like pains in the right upper quadrant, fever, chills and marked tenderness over the gall bladder. A diagnosis of empyema of the gall bladder was made and the patient was prepared for transportation to the hospital for surgical operation. During such preparation,

incident to turning in bed the patient says that she felt instantaneous relief from the pain. In a very few minutes she became much nauseated and vomited a fairly large amount of purulent, bile-stained material. About one-half hour later the patient was seized by diarrhea, the fecal material consisting chiefly of pus and bright red blood. Following this episode the temperature subsided and complete recovery ensued. She remained entirely well for twenty years.

Two years ago there was the onset of dull aching pain just to the right of the epigastrium. The pain usually came on one or two hours after meals and was relieved by taking large doses of bicarbonate of soda. There was a constant feeling of uneasiness in the upper part of the abdomen. She had a great deal of gaseous distention but had not experienced any severe abdominal pain. There was occasional nausea and vomiting, the vomitus being bile-stained. Her diet consisted of milk, toast and cereals. There was no history of jaundice. She was much constipated and during the past two years she had lost 36 lb. in weight. Systemic review revealed the following: She had occasional headaches and her vision was hazy at times but there was no history of diplopia. There were occasional colds but there was no cough or hemoptysis. There was no history of pleurisy. The patient complained of attacks of palpitation of the heart incident to exertion and experienced occasional attacks of choking at night. Her urinary history was entirely negative. She had passed through an uneventful menopause one year ago. She had two children living and well and had had no miscarriages. The family history revealed that her father had died of apoplexy. Her mother was living but complained of stomach trouble. One sister was living who also complained of stomach trouble and one sister had died of cancer of the rectum.

Physical examination revealed a well developed and well preserved white female about fifty-six years of age who complained of abdominal pain. She had the appearance of

* From Division of Surgery, Wheeling Clinic, Wheeling, W. Va., Submitted for publication April 1, 1931.

good health. Her weight was 130 lb. There were numerous striae about the trunk and extremities which gave evidence of recent loss



FIG. 1. Fistula between gall bladder and stomach.

of weight. There was no icterus or pallor. The pupils were normal. Detailed examination of the chest revealed no evidence of cardiac, pleural or pulmonary disease. The pulse rate was 80 per minute and the blood pressure was 125/78. The abdomen was moderately pendulous and relaxed. There was no distention or visible peristalsis. There was definite tenderness and muscle spasm in the gall-bladder region and the entire right upper quadrant was more or less tender. The liver and spleen were normal in size and no tumor mass was palpable. Pelvic examination was negative. Wassermann test was negative. The urine and various blood counts were reported as normal. A tentative diagnosis of chronic cholecystitis was made and the patient was referred to the x-ray department for further study. Dr. Kalbfleisch reported the following findings:

"Gastrointestinal x-ray showed a medium sized hypertonic stomach, position left and in front of the spine. The pylorus was to the right of the third lumbar vertebra, round, regular and well-outlined. The duodenal bulb was to the right of the second lumbar vertebra. The outline of the stomach and bulb was perfectly smooth. There was no hold-up in

the esophagus. There was intermittent patency of cardia and pylorus. Peristalsis was early and fairly active and evacuation was early. Both curvatures of the stomach were freely movable. There was sharply localized tenderness at and just to the right of the duodenal bulb. Six-hour examination showed no residue and no hypersecretion. The remainder of the intestinal x-ray also was negative. A flat plate of the gall-bladder region showed no stone shadows and no definite gall-bladder shadow. After intravenous injection of 2.4 gm. of iodeikon the sixteen-hour picture showed no gall-bladder shadow but traces of the dye were distinguished in the small intestines. The twenty hour picture failed to show the gall bladder. The twenty-four hour picture of the gall bladder which was made during the course of the gastrointestinal x-ray showed a sharply outlined barium shadow the size of a pea 1 in. above the hepatic flexure and a fainter, thin, irregular linear shadow extending upward and mediad from the first.

"Diagnoses: Chronic cholecystitis, enterocholecystic fistula."

Surgical treatment was advised and the patient was admitted to the Ohio Valley General Hospital on May 19, 1930.

During the preoperative period the patient continued to complain of pain following her meals. A Sippy routine was ordered but the patient continued to complain of her discomfort. She suggested that the doses of alkaline powders were not large enough to relieve her and asked to have a large box of baking soda left at her bed side. This was provided and at the onset of her pain she was observed to take as much as two or three heaping teaspoonsful of baking soda and in a short time thereafter she experienced complete relief.

A fractional gastric analysis was made and much to our surprise the free and combined acidity was much less than normal in all specimens. There was no free hydrochloric acid in the fasting specimen which was not bile-stained. The remaining specimens were heavily bile-stained. A specimen was obtained from the stomach during an attack of pain and it contained neither free acid nor bile pigments. What was the reason that the patient was relieved by the massive doses of bicarbonate of soda? Certainly there was no excessive hyperacidity to be corrected. One

must suppose that these large doses gave relief by quieting excessive peristalsis. During the entire preoperative period there was no elevation of temperature.

On May 19, 1930, laparotomy was done by Drs. Fulton and Rankin. The gall bladder and the distal end of the stomach were densely adherent. There were numerous adhesions throughout most of the right upper quadrant. The gall bladder was about twice its normal size and was filled with small soft stones and sludgy sediment. By breaking up the numerous adhesions between the gall bladder and the stomach the fistulous tract was discovered opening into the stomach on the anterior surface about 1 cm. proximal to the pyloric vein. The common duct was dilated and it contained a soft stone the size of a small hickory nut. This stone was removed and the patency of the common duct was proved by passing a probe through it into the duodenum. The adhesions were broken up about the stomach and gall bladder, the fistulous opening in the stomach was repaired and the gall bladder was removed. A T-tube was placed in the common duct and the abdomen was closed after placing a cigarette drain in the gall-bladder fossa. For several days following operation bile drained freely from the T-tube and examination of the stools showed bile pigment. On the patient's fourth postoperative day the drainage from the tube was diminished. At the end of a week

the patient became slightly jaundiced and considerable sediment drained from the tube. The stools contained bile pigment but the icterus index was 24. For the next two weeks the T-tube was irrigated daily with normal saline and large amounts of sediment were recovered. During this time the jaundice gradually disappeared, and the bile was normal in color and contained no sediment. The T-tube was then clamped off. The icterus index and stools remained normal.

One month after the operation the T-tube was removed and was followed by immediate healing of the wound. She was discharged from the hospital during her fifth postoperative week.

The patient returned for examination ten days later. She said that she was free from pain but the incision had broken open and was draining a small amount of bile. The stools were of normal color and there was no icterus.

She returned for observation in December, 1930. At that time the wound was completely healed and there had been no further drainage of bile. She had gained 25 lb. in weight and stated that she felt fine. She partook of a general diet without any gastrointestinal complaints. She required occasional mild cathartics.

Summary: A case of gastrocholecystic fistula is reported which was successfully treated by surgical operation.



THE ACIDOSIS TREATMENT OF INOPERABLE MALIGNANT TUMORS*

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NEW YORK

THE writer's recently published book on "Cancer,"¹ contains a casuistic taken from the literature by means of which it has been attempted to show that for inoperable cancer acidosis is the given remedy. In these cases the alkalosis prevailing in the untreated system of the cancer patient, we believe, was turned into acidosis by fever, by Coley's fluid, by starvation, by artificial hyperemia, by induced inflammation, and by the administration of parathyroid extract, of calcium, of acids and other drugs, and of acid colors. All this is discussed in the book in detail.

A further method of producing acidosis for therapeutic purposes in such cases has been worked out experimentally and applied clinically by B. Fischer-Wasels of the Senckenberg Institute of Pathology at the University of Frankfurt, Germany.² Its principal features are the breathing, by means of a tight-fitting mask for two to four hours daily, of a gas mixture composed of pure oxygen plus $4\frac{1}{2}$ per cent carbon dioxide, combined with intensive deep x-ray therapy of the primary tumor and of its eventual metastases after the Holfelder depth-irradiation method; the administration of large quantities of hydrochloric acid, in liquid form or in tablets, three times daily; and, when indicated, the ultraviolet irradiation (Alpine sun) of the entire body for the purpose of activating the reticulo-endothelial system.

The mixture of the two gases was advised by Yandell Henderson several years ago as useful at the close of every general gas inhalation anesthesia on account of its intrapulmonary physiological effect: enforcing deep inspiration on the part of the patient. It has been currently in use in American hospitals for the purpose mentioned.

The first successful clinical case, after years of encouraging experimental results, dates from December, 1928. Result: Apparent complete cure of an inoperable metastasizing cancer of the stomach after four and three-fourth months of intensive treatment. The German publication³ containing the case came to hand, unfortunately, too late for inclusion of the case in the book, an occurrence, we have regretted exceedingly.

According to the history taken by the writer the case is as follows:

Mrs. M. T. aged fifty-four, married thirty-three years, seven children, all living. Spring 1928 began to lose weight very rapidly, grew weak, pale; "heart-burn." June 1928 x-ray; radiologist interpreted film: probably gastric ulcer. July 1928, began to lose appetite; no hydrochloric acid found on gastric analysis, frequent "stomach cramps." Internal treatment; got worse. End of August 1928 went to Battle Creek: stomach test (bloody) again no hydrochloric acid; x-ray diagnosis: cancer of stomach; considered inoperable. Treatment: Careful diet, hydrochloric acid, general régime. Patient desired operation; went to Mayo Clinic. Here stomach test again showed blood; x-ray examination; had by that time lost more than 25 lbs. Diagnosis: advanced cancer, wall of stomach. Exploration advised; probatory incision; inoperable; abdomen closed.

Fischer-Wasels, (l. c., p. 242), publishes the following letter, which had been handed to the patient at her request at the time of her discharge from the clinic:

Mayo Clinic, Rochester,
Minnesota, Nov. 13, 1928.

Mrs. J. T. She registered here Oct. 24, 1928, giving a history of stomach trouble beginning in June.

Our examination showed negative urine analysis and blood Wassermann, hemoglobin

* Submitted for publication November 24, 1931.

of 58 per cent; red blood cells 3,890,000; white blood cells 10,600; differential count practically normal. Gastric analysis showed total acidity of 22 and no free hydrochloric acid. X-ray examination revealed a carcinoma extending fairly high on the posterior wall and greater curvature of the stomach.

On Oct. 31 she was explored by Dr. C. H. Mayo. There were many adhesions in the upper right abdomen secondary to an appendectomy and cholecystostomy done in 1916. The upper three-fourths of the stomach including all the posterior wall and part of the anterior wall was involved with carcinoma; there was also involvement of the lymph nodes about the cardia just beneath the diaphragm and along the spine. A gland removed from the gastrocolic omentum for biopsy showed carcinoma. As there was no obstruction a gastroenterostomy was not done and the abdomen was closed as an exploration.

She was discharged from our care on Nov. 11. We shall appreciate anything you may be able to do for Mrs. T.

(signed) Henderson,
First assistant to Dr.
C. H. Mayo.

Lately the Mayo Clinic kindly furnished the writer, at his request, the following report of the case with permission to publish it:

Sept. 16, 1931.

Dear Dr. Meyer:

Your letter concerning Mrs. J. T. has come to my attention. I operated on her Oct. 31, 1928, making an abdominal exploration. There was a tumor of the stomach which apparently involved the upper three-fourths of the stomach, all the posterior wall and part of the anterior wall, with glandular involvement about the cardia just beneath the diaphragm. There was also glandular involvement along the lesser curvature and along the spine. A gland was removed from the gastro-colic omentum which apparently showed very cellular carcinoma. There was no obstruction and inasmuch as the tumor involved so much of the stomach no attempt was made to section the growth and the wound was closed as an exploration. There were many adhesions of omentum to the right abdominal wall covering in the gall-bladder area. The adhesions

were secondary to an appendectomy and cholecystostomy done elsewhere. The stomach was more like the linitis plastica type. These cases often go from two to as long as four years. I just received word of another somewhat similar case, a doctor's wife, whom I explored in 1929 and who has just died. While one might be mistaken about the clinical and pathologic diagnosis we feel quite positive that the diagnosis is correct.

If Mrs. T. has had a recent examination we would be very much interested in getting a report of her present condition.

(signed) C. H. Mayo.

After her discharge from the Mayo Clinic the patient returned to New York with expectation to live but a few months. Meanwhile her husband had learned through the newspapers about the work of Prof. Fischer-Wasels. In December 1928 arrangement was made by cable to transfer the patient to Frankfurt, Germany.

She presented herself to Prof. Fischer-Wasels in a bad general condition and cachectic appearance on December 9, 1928: poor ingestion of food, intense cramp-like pain in upper abdomen after every meal; vomiting; weight 133½ pounds. A large mass was easily palpable in left hypochondrium; x-ray examination showed a tumor of stomach of the size of a child's head.

Admitted to Clinic. She was immediately subjected to the described treatment: deep x-ray, about fifteen minutes once per week; breathing of the gas mixture for two hours daily in three stages of forty minutes each, "religiously"; hydrochloric acid internally, gradually increasing dose from 10 to 35 drops in some water before meals, three times per day.

After four weeks the general condition was much improved, intake of food increased; pain and vomiting had ceased. After three months the tumor had shrunk to about one-third its previous size, as proved by roentgenogram and palpation, still about as large as a fist, hard and irregular, easily palpable; patient took long walks daily in spite of intense winter weather. May 1st, neither palpation nor x-rays could demonstrate the presence of a tumor, contours of stomach

perfectly normal; peristalsis unobstructed under the fluoroscope. Soon after patient sustained a Colles' fracture which took a normal course. Middle of May 1929 she could be discharged, apparently cured, with a considerable gain in weight and in perfect general condition.

She returned to New York, where she came under the care of Dr. G. Bucky, now domiciled in Berlin, Germany. She continued breathing the gas mixture as taught in Frankfurt for several months, giving it up definitely in September of the same year, three months after having reached home, while faithfully taking hydrochloric acid in liquid and in tablets. She was seen in good health by Prof. Fischer-Wasels at the time of his visit to America, on September 19, 1929, nine months after the beginning of the treatment. In February of this year, 1931, she returned to Frankfurt for further "prophylactic" x-ray treatments (Prof. Holfelder), of about fifteen minutes each, two to three times per week. X-ray film showed the stomach contours perfect, ("tadellos"). She stayed in Frankfurt eight weeks, then returned home to New York City.

Lately this writer, after having found out the whereabouts of the patient, had the chance of taking a careful history (see above) and of examining her personally, Oct. 19, 1931, when the following status was noted:

Strong looking woman, now fifty-six years, somewhat pale, color attributed by patient to temporary overwork at home, cooking, scrubbing and so forth. Two abdominal scars, each 6 to 7 inches long over right rectus (from operation on gall-bladder) and in median line (from exploratory laparotomy). Abdomen soft; no palpable tumor; liver not enlarged; no fluid in peritoneal sac. Heart sounds normal; pulse 72; no cough. Vaginal examination: nowhere infiltration in small pelvis. Appetite good, no selected food; eats moderately; bowels moving with mineral oil. Feels fine, sleeps well; works hard, attending alone to household duties regularly for a family consisting of 6, week ends often of 10 to 12 members. Weight (stripped) 172 lbs. pH 7.338, normal, taken at laboratory of Lenox Hill Hospital, (Dr. Anna Goldfeder). Blood count:

hemoglobin 73 per cent; reds 3,610,000; whites 6,500.

This would seem to indicate that the acidosis treatment had accomplished everything expected of it, i.e. "cleansing of the whole system of the patient of everything pertaining to cancer: susceptibility, tumor, disseminated cancer cells, metastases, and recurrence."

Clinically, the patient is at present to all appearances cured. In order to keep the pH at the normal level she continues to take hydrochloric acid and is ready to resume the O_2CO_2 inhalation should periodic pH examination reveal a threatening recurrence of the disease.

Other cases of advanced carcinoma of the stomach, of the breast, uterus, intestines, and within the esophagus treated by the same method in Frankfurt, are on record,² almost every one of the patients having been benefited by the combined acidosis treatment.

In one of the latter patients a far-advanced malignant stenosis of the lower part of the esophagus, that had slowly developed in the course of two years in a man aged sixty-three, only liquid food in small quantities could be taken with difficulty. After eighteen days of combined treatment there was great subjective improvement in the general condition of the patient; the stenosis proved less obstructing, he could take solid food. Two weeks later the irregularities of the esophageal mucosa, still seen in the roentgenogram fourteen days earlier had disappeared, also the former severe pains radiating to the back. It was difficult to make the patient understand—the clinical diagnosis having been withheld from him—that he could not be considered cured. He was at his request temporarily discharged from the hospital with full ability to swallow any kind of food.

Fischer-Wasels expresses regret considering the exact scientific proof of the value of the treatment in this case that the man's reduced general condition at

the time of his admission to the clinic contraindicated esophagoscopy with biopsy. However, history, clinical picture and x-rays (see l. c. pages 244 and 245) clearly pointed to a cancerous stricture of the esophagus. Not long afterward the patient insisted upon an operation for hemorrhoids, developed double pneumonia, and was seriously ill for several months. When convalescing, symptoms of the old trouble re-appeared, necessitating resumption of the original treatment. When reporting the case, the patient was still at the clinic.

It is obvious that a malignant disease of this type will require several months of faithful attendance without interruption, not weeks, should improvement become permanent.

In a case of diffuse general carcinosis following amputation of the right breast for cancer, multiple metastases in both lungs, pelvis, spine and brain, and with palpable cancerous nodes in the infra-clavicular and supra-clavicular region disappeared in the course of four months' intensive and uninterrupted application of the same method of treatment. The presence of the metastases in the various organs mentioned as well as their final complete disappearance were substantiated by the examination of the professors of neurology and ophthalmology of Frankfurt University and by the x-rays. This case, reported by Fischer-Wasels in 1930, is still being followed up. It represents a most remarkable and convincing observation of the efficacy of the treatment under discussion.

Long years of observation have taught the writer that a certain new fact in science is most likely to be correct or has at least a probability of being true, if two investigators, independently, by experiment or otherwise, have come to the same identical conclusion.

In this instance the writer said on page 405 of the book "Cancer":

What puts this author at the end of his investigations in such an optimistic mood is

the fact that the theorizing in Part 1 of this book has to his agreeable surprise landed him, as the discussion and the casuistic of Part 11 show, where the very things, which his analyses suggest *should* be done, are found to have *already been done* by various clinicians sporadically and sometimes accidentally, but successfully. Without always being able to tell why, they achieved cures in ways postulated by the deductions which inevitably follow from our arguments. The agreement of theory and practice in these instances is so thorough that there would seem to be contained somewhere in our theoretical considerations a small modicum of truth, for such a close agreement cannot possibly be accidental.

The cures cited in the book were the so-called "miraculous cures" in inoperable cancer patients who got well by accidentally developed erysipelas, prolonged other types of feverish conditions, severe hemorrhage, long lasting not intended hunger, etc.

Outside circumstances not under his control rendered it impossible, as mentioned above, that Fischer-Wasels and Holfelder's cooperative work had come to his notice before the publication of the book. Later the reading of the late Aldred Scott Warthin's fascinating article "The Newer Therapeutic Attack on Cancer" read in part before the Utah State Medical Association, Salt Lake City, Utah, September 11, 1930, and published under "Editorial" in the October issue of the *Annals of Internal Medicine*, 1930, brought it to his attention. And there he found the working hypothesis suggested in his book transposed into clinical reality. Among the cases studied in human beings at Frankfurt the patient with inoperable cancer of the stomach and the recurrent cancer of the breast with multiple metastases² appear to the writer particularly significant.

One of the reviewers of the author's book "Cancer" who publishes his opinion in the July number of the *American Journal of Cancer*,* concludes his exposé as follows:

Toward the end [of the book] the author commits himself bravely to a theory of cancer,

* Vol. 15, No. 3, 1931.

which, unfortunately, is a very slender reed—that of the alkalinity of the blood. It is probably true that the blood in a certain number of cases of cancer is slightly alkaline, but it is not always so. Whether this alkalinity has anything to do with cancer or not, has never been shown, as it occurs, also, in other diseases. The present reasoning is too much *post hoc propter hoc*. The more carefully the matter of the blood pH is studied the less clear it becomes, and competent chemists who have worked within the last year or so are quite convinced that there does not exist an actual alkalinity due to an excess of basic materials in the blood, but rather that the carbon dioxide concentration may be the important factor. In any case, the determinations are difficult, the sources of error abundant, and even the physical chemists are a little less dogmatic than they were a couple of years ago. They are not so certain now what is the best method of determination, and they are not quite certain what their determinations mean after all. If this is true of simple solutions, how much more difficult must be such determinations in complex fluids like the blood. Nevertheless, Dr. Meyer places his money fearlessly on this cause of cancer, and believes that the rendering of the body slightly acid will cure the disease. The only criticism which can be made of this cure is the one which applies to almost all other cures; that is, that it does not work!

In the case, related extensively before, the acidotic treatment certainly *did* work, also in the majority of the other cases cited.

The report of the case mentioned above will likely also convince many readers that the sentence found on p. 396 of the book "Cancer," viz., that "inoperability does not necessarily mean incurability," is probably correct, and that it was the acidotic treatment, in combination with x-ray therapy, which has cured a patient who suffered from an inoperable gastric malignant tumor, the undisputed presence of which had been proven by exploratory laparotomy at the hands of an expert and by microscopical examination of a metastatic node made at a laboratory known for its reliability and exactness.

What we clinicians now have to provide is "a series" of cancer cases cured by acidosis treatment after they have been pronounced inoperable by competent surgeons.

It deserves to be emphasized here that the x-rays themselves appear to have an acid effect on the blood. The literature dealing with this effect is still scarce. A search by the staff of the Bibliographic Division of the Library of the New York Academy of Medicine yielded only two recent articles:

1. Davy, Leita: Studies of the Systemic Effect of Roentgen Rays. II. The Acid Base Balance and the Serum Protein of Dogs before and after Irradiation. *Am. Jour. Roentgenology*, 25: 255-265, 1931.
2. Woodward, H. C., and Downes, H. R.: The Effect of Radiation on the Acidity of Blood. *Am. Jour. Roentgenology*, 25: 271-275, 1931.

The other day a third article was called to our attention by Dr. H. E. Illick of the Radiologic Department of the Lenox Hill Hospital: M. Loeper and J. Tonnet.: *Bull. Assoc. franç. pour l'étude du cancer*, February 1923; reported in *Radiology*, April 1924, p. 276. The authors have studied the effects on the blood of repeated exposures of cancerous tumors to x-rays. After 5 or 6 applications of doses ranging between 5 to 10 H units there was an increase of from 4 to 12 per cent of albumin in the blood serum, probably due to an increase of globulin; an increase of from 0.06 to 0.18 in amino-acid content of the serum; an increase in total lipoids of the serum; and a large increase in the sugar content of the serum.

The changes, the authors think, are due to the fact that repeated doses of x-rays disintegrate the cells of cancerous tumors and liberate quantities of globuline, amino-acids, sugar and lipoids, which pass into the blood stream.

Joos and Heeren report (Fischer-Wasels, l.c., pg. 468) that a few minutes after exposure of patients with malignant tumors

to x-rays the lactic acid content of the blood had risen 10 to 40 per cent. Four to six hours later they found this increase reduced by 20 to 35 per cent. They consider the reduction of the tension of CO_2 in the alveoli due to the rays responsible for the sudden increase of lactic acid in the blood and the following quick drop to be a consequence of the increased disappearance of the acid in the organism.

Further clinical experience will likely demonstrate that the combination of this acidotic treatment with other methods which are known to have favorably influenced inoperable malignancy will be of benefit. Besides the deep x-ray treatment we think particularly of prolonged artificial (synthetic) fever.

A high frequency apparatus manufactured by the General Electric Company of Schenectady, N. Y.,—the same type as distributed by this corporation to various medical institutions throughout the country for trial, in 1930,—has recently been installed by said Corporation at the Lenox Hill Hospital of New York City. It is the magnanimous gift of a friend who is interested in the treatment of cancer. Personally, we have hopes that, after the method has been sufficiently worked out, it will prove to be of benefit in cases of inoperable malignant tumors, in combination with direct acidotic treatment.

It would seem to us that we are justified in our expectation in view of that celebrated case of Wilhelm Busch, Professor of Surgery at the University of Bonn, Germany, observed in 1866: a far advanced case of multiple fast growing sarcoma of the skin of the face and head with involvement of the lymphnodes of the neck in a woman who had been admitted to the Surgical Clinic.⁴ She caught a severe infection of erysipelas, recovered after weeks of most serious illness and was finally cured locally as well as generally of the sarcomatous tumors. No doubt, the intense persistent hyperemia and acute edema produced by the erysipelas in addition to the long-continued high fever, with its

acidotic effect and subsequent fatty degeneration of the tumor cells with absorption of the fatty detritus by the lymph vessels had been the curative agents.

It is this recession—in the case just mentioned even total disappearance—of a far advanced malignant tumor by means of prolonged fever, and similar observations made by others not only with erysipelas but in the course of many feverish affections, as scarlet fever, typhoid, cholera, smallpox, pneumonia, malaria, acute tuberculosis, rabies, which make us hope that also synthetic (artificial) fever will prove to be one of the factors that do good to otherwise hopelessly lost patients.

We do not believe that the type of the infectious micro-organisms nor their toxins are responsible for the recession of the tumor tissue in the course of the protracted fever that had been created, but the increased body temperature with its activating biological effect as such.

The apparatus can produce fever up to still permissible levels within a short time.

Further details of the acidotic treatment in combination with synthetic fever and other useful procedures to the same end must and will be worked out clinically in time.

If colleagues, especially surgeons, in active practice, attached to hospitals, will begin to consider inoperable cancer patients as not absolutely hopeless cases, as is more or less the general belief today, but as patients who need careful general and local attention with hospitalization, many patients of this kind—we have no doubt—will still prove to be amenable to treatment of the general system besides a careful surgical attendance to their local trouble with well-founded hope for improvement and even recovery. Such patients will then not drift into the hands of the quack.

The four cardinal questions which are now up for decision before the medical profession are, to our mind, the following:

1. Is cancer an infectious disease?
2. Is cancer a systemic disease?

3. Can cancer develop only in an alkaline medium, or also in an acid medium?

4. If cancer can develop in an alkaline medium only, is the alkalinity of the blood serum the primary or the secondary factor in the systemic trouble, viz. did it develop before or after the appearance of the local tumor and its eventual generalization?

These four cardinal questions have to be settled as soon as possible by the medical profession. The more intense, unbiased and aggressive the scientific discussions are going to be, the more thorough and up-to-date the operative and inoperative treatment in cases beyond radical surgery,* the better for suffering humanity.

We venture to express here our present conviction and answer to the four questions and hope to be permitted to do so without running the risk of being accused of arrogance, a faculty entirely foreign to our mind. All we desire to do is to try and bring out in clear relief as a working hypothesis for ourselves, as far as we are able, the four cardinal questions and the required individual replies hereto as they appear to us at this moment.

The four questions with the answers are as follows:

Question 1: Is cancer an infectious disease; are microbes or parasites responsible for its etiology?

Answer: We do not believe cancer is an infectious disease. To our mind neither bacteria nor parasites are directly responsible for the causation of cancer. The phenomena observed in cancer are explainable by biologic physical chemistry.

Question 2: Is cancer a systemic disease?

Answer: We believe it is. The tumor is a symptom of the general disease, not the disease itself.

Question 3: Can cancer grow in an acid medium in man?

* The addition of incomplete operations with the subsequent secreting wounds in cases beyond radical surgery, removing and destroying as much of the cancerous tissue as can be reached with the electric knife and actual cautery, is absolutely necessary in the treatment of radically inoperable cancers for the sake of drainage to the outside. If the skin and deeper tissues are nowhere divided, but remain tightly closed during the systemic treatment, these patients will die from absorption of the protein decomposition products formed by the treatment itself.

Answer: We do not believe it can. It grows in an alkaline medium only.

Question 4: Is the alkalinity the primary or the secondary symptom of the systemic disease, in other words, is the gradually increasing alkalinity of the blood serum, in addition to the other etiological predisposing factors, as explained in the writer's book, the cause of the appearance of the tumor, or does the tumor and its eventual metastases produce the gradual shifting of the pH to the alkaline side?

Answer: We believe the gradual increase of the alkalinity of the serum is the primary lesion in the system. Its presence in conjunction with the other causes favors the appearance of the tumor wherever a chronic local irritation is present.

We hope that the discussion of these four cardinal questions will remain permanently on the program of medical societies and associations until the majority of the medical and affiliated professions have come to a decision regarding the same. We have no doubt that the explanation on basis of biological physical chemistry will come out victoriously.

A few words still regarding cancer prophylaxis.* It seems to us that the care for normal, better still for increased circulation by means of Bier's artificial hyperemia plus regular systematic local massage intermittently applied for a long time etc., in conjunction with the maintenance of proper functioning of organs which are clinically particularly threatened by the development of malignancy, also timely strict attention to the treatment of so-called precancerous symptoms as well as to correct balancing of the serum salts, are at the bottom of the question. Local stasis must be prevented at all hazards. Local stasis, with its inevitable consequence of local coagulation of blood and of lymph, † is, according to our opinion, the very begin-

* Cf. author, book "Cancer," pg. 402.

† Author, *l.c.*, pg. 280. Cf. Adair, Frank E., and Bagg, Halsey J. Breast stasis as a cause of mammary cancer; *Internat. Clinics*, Vol. 4: 19, 1925; and Adair and Pack: The use of the electric breast pump as a prophylactic measure, etc. *Annals Surg.*, July, 1931; also: The Genesis of Cancer by W. Sampson Handley, London, Kegan Paul, Trench, Trubner & Co., 1931, pg. 195 ff: "Mode of action of lymph stasis."

ning of the formation of "a focus," which in turn, in the light of a systemic conception of malignancy, is causing the formation of the tumor cancer.* We know that a malignant tumor does not occur, or, at least, very exceptionally, in continuously active organs with a massive circulation of blood and lymph. We refer to the heart, the parenchyma of the lungs, the spleen, the duodenum, the cross-striped muscles and the breast of a dairy cow, which, though battered and injured by the roughness of the young calf for weeks and months, and maltreated by the old time process of milking day after day does not develop cancer. These organs, many of them at work day and night, and endowed with a remarkably profuse blood circulation, do not give "the focus" a chance to grow and develop; it is washed away by the fast flowing blood and lymph, and that ends, we believe, the development of malignancy at this place.

These physical factors in the etiology which we consider of great importance, deserve to be emphasized again and again. They, too, ought to be carefully studied, thoroughly discussed and enlarged upon by a group of men who are vitally interested in these questions. Members of an "*American Association for Cancer Prophylaxis*" would devote their energy also to them and thus perhaps in course of time solve that highest aim of the medical profession, as far as cancer is concerned: the attempt to render the formation of the tumor cancer impossible.

Until this has been accomplished and has borne fruit, the pursuance of the acidosis treatment of inoperable malignant growths in all its phases and variations, combined with active operable removal of the cancerous growths as far as they can be reached by the electric knife and the actual cautery might well carry the torch of progress and enlightenment forward quickly from the clinical point of view, by mere empiric clinical observation of results obtained, while the scientific discussions and laboratory investigations of the four cardinal questions enumerated above are going on.

* Cf. author, l.c., pg. 280 and 281.

† See author, l.c., pg. 403.

But let us clinicians do our part of the work in closest cooperation with the pathologists, the biological physicists and the biological chemists, and with our colleagues in cancer research. Let the latter teach us by their experimentation on animals why and how nature accomplishes what we clinicians have observed in man. If anywhere in medical science, then here, it seems to us, "closest cooperation" among the various representatives in the branches of medical and affiliated sciences must be the keynote in order to make progress. Particularly should the cancer research men work hand in hand with the clinicians who have seen, operated upon and attended to the disease cancer in human beings often until the death of their patients, and the clinicians with the laboratory workers.

Meanwhile radical modern cancer surgery will continue to bring its blessings to operable cancer patients, as heretofore. But operation should be followed in every instance by acidotic aftertreatment for weeks or months to try and avoid recurrence of the tumor and to try and avoid the formation of or to treat already existing metastases. The periodically correctly determined hydrogen ion concentration of the blood will tell us *when* this aftertreatment may be discontinued, that is to say, whenever the pH is found to be 7.36 or less.

SUMMARY

1. In patients afflicted with technically inoperable cancer, with or without metastases, all factors known to produce acidosis of the blood, properly selected, combined and adapted to the case in hand should be put into operation as quickly and as vigorously as possible.

2. The biological acidosis treatment of inoperable malignant tumors must be worked out further by cooperative efforts of the members of the medical and affiliated professions.

3. To all appearances those who are working along the lines of acidosis treatment of patients afflicted with inoperable malignant tumors are on the right track.

[For References see p. 127.]

THE DIAGNOSIS OF URETERAL CALCULI AND THE PROBLEM OF THEIR CONSERVATIVE MANAGEMENT*

ALBERT M. CRANCE, M.D., F.A.C.S.

GENEVA, N. Y.

MODERN urology, in spite of its rapid forward strides, is still facing many problems in the diagnosis of stone. Likewise, the management of ureteral stones still offers its problems. The conservative believers help



FIG. 1. Mr. W. H., aged fifty. Definite left renal colic. Negative findings with plain x-ray film. This roentgenogram clearly shows location of stone above bony pelvis with aid of urography. Note dilatation of ureter up as far as it can be seen in this illustration. This stone was felt with a catheter, and a definite diagnosis made.



FIG. 2. Same case. One week after first ureteral dilatation, clearly shows stone has descended fully 3 in.

diagnosis as well as the management of stones in the ureter. The diagnosis, most assuredly, has greatly improved with the finer ureteral technique as well as with advancement in x-ray methods. However, there are still many cases of non-shadow producing calculi in which it is often difficult to make a positive or a negative

the stones along the path and wait, whereas the radical believers give up hopes very early and insist that a surgical procedure is required and advocate ureterotomy, shall we say too frequently?

It is the purpose of this paper simply to discuss very briefly some of the chief points of interest in both the diagnosis and management of ureteral calculi. Nothing concerning renal stones, or vesical stones, or when they occur with ureteral stones will be included. They offer an entirely

* Submitted for publication June 26, 1931.

separate consideration. On the other hand, there is perhaps nothing original added to the picture.

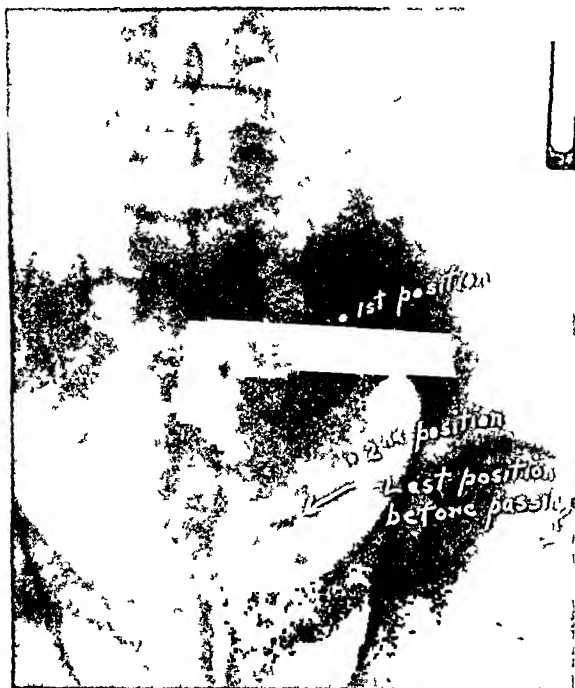


FIG. 3. Same case. Plain film shows stone to be in intramural portion of left ureter. At this time ureter again dilated, six days after which patient successfully passed calculus. (This case emphasized the fact that calculi caught in ureter, between upper and lower borders of sacrum, will not always cast a shadow even though shadow is later seen to be high in calcium content.)

DIAGNOSIS

In the average case, the diagnosis may be made from a carefully taken and carefully studied history. This may seem to many an absurd statement, but it is nevertheless worth while considering most thoughtfully. It is especially true in the acute, severe cases. Acute renal colic, coming on suddenly, often preceded or accompanied by bloody urine, is indeed almost pathognomonic of ureteral stone. Most cases, of course, do not give any history of macroscopic hematuria. But, the character of the pain is quite the same. Other conditions which give us the picture of renal colic are chiefly strictures of the ureter, volvulus or kink, none of which

are usually so sudden, or "knife-like" in character. They are more often less severe, and more gradual in their onset. Stone



FIG. 4. Mrs. C. C., aged forty-one. Terrific right ureteral colics. Recently operated elsewhere for appendicitis. Plain x-ray absolutely negative. Right urogram shows ring shadow in middle third of ureter. Pelvic retention of 14 c.c. were found. Ureter dilated for forty-eight hours. Patient discharged free from pain, passing stone ten days after leaving hospital. Stone was rather large, and might easily have indicated open operation.

colics actually "come from out of a clear sky," so to speak. Their pain is sharp, or "knife-like"; and, likewise, the colic may cease just as suddenly as it began. This feature in itself is most important in many histories. The character of the referred pain is also important. It may often encircle the waist in a downward direction. It may or may not cause any bladder discomfort, but often does cause an aching in the genital region, or down the inner surface of the thigh as far as the knee on the side giving origin to the colic. Curiously, one patient in this series presented only a complaint of an aching testicle. The aching sensation disappeared entirely



FIG. 5. Miss D. G., aged twenty-one. Severe left renal colic for over a week prior to admission. Sensation of obstruction met in middle third of left ureter. A second No. 5 passed this area with some difficulty. This roentgenogram clearly shows calculus between fourth and fifth lumbar vertebrae.



FIG. 6. Same case. After two weeks' freedom from pain more colics occurred. Plain film at this time with catheter in left ureter showed no shadow of stone. Urogram at this time clearly locates calculus as indicated just below brim of sacroiliac region. At this time it had descended 2 in.

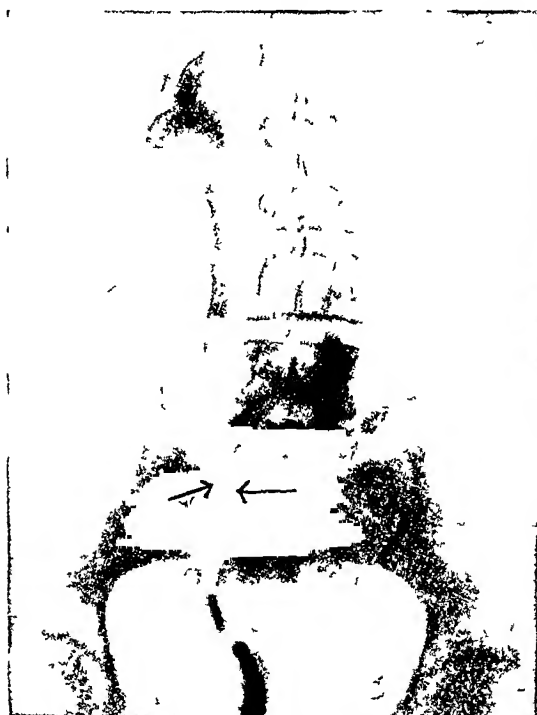


FIG. 7. Mr. M. B., aged forty-two. Large ureteral dilatation above stone caught in region of sacroiliac joint. Stone successfully passed two weeks after one ureteral dilatation.



FIG. 8. Mr. D. H., aged forty-seven. One of stones which required removal by ureterolithotomy. Note prolonged edges which would eliminate possibility of this stone passing through intramural portion. This man had vague pains in left back for over two years.

after a symptomless hydronephrosis was relieved (Fig. 14).

The physical examination usually re-

policy not even to make an x-ray study until the patient is on the cystoscopic table, and whenever possible, with a



FIG. 9. G. O. B., aged forty. Rather large left ureteral stone which was successfully passed following two ureteral dilatations with inlying catheters, and irrigation upon removal.



FIG. 10. Mrs. A. R., aged twenty-nine. Left ureteral calculus just below pelvic brim producing severe colics. Stone passed after one dilatation with a No. 9 bougie. No further colics since stone passed. Dilated appearance of elongated type of pelvis, together with dilatation immediately above stone, can be attributed to spasm in middle third of ureter, owing to fact that a No. 9 bougie passed entire length without difficulty after working past stone.

veals marked tenderness at the costo-vertebral angle; the old percussion sign of Murphy is positive, but only if the ureter is obstructed at the time of the examination. It is often absent by the time the consultant arrives. Furthermore, one gets the same physical signs with the other types of ureteral obstruction; consequently the physical examination leaves four possibilities, stone, stricture, volvulus or kink, but in so far as stone is concerned, the physical examination offers nothing positive.

The x-ray diagnosis, if done entirely separately, is most discouraging in the majority of cases. One is never at all positive with a plain x-ray film. It means nothing positive even if one is fortunate enough to see a shadow: it has to be proved later. It is therefore a procedure which, used alone, is to be discouraged. It might even be stated here, that it is our

catheter up beyond the calculus. In this series of 77 cases, 57 or 74 per cent showed rather definite roentgenographic shadows of the calculi prior to the filling of the ureter with an opaque solution. It should be clearly emphasized that x-ray technique in ureteral stones must be most carefully considered. On the other hand, one must study his x-ray findings with great care. Many calculi are missed by too quickly passing a negative opinion on a film in which later the stone shadow may be discovered.

PROBLEM OF MANAGEMENT

As Barney and Chute¹ have recently stated in an article devoted to this subject,

¹ Barney, J. D., and Chute, R. The management of calculi in the lower ureter. *J. Urol.*, 25: 173, 1931.

each case presents a problem of its own. No definite or absolute rules can be followed because there are no two cases of

on. It is reasonable to expect that such a wide variation in percentage figures, can only be attributed to the fact that one



FIG. 11. Mr. G. A., aged thirty-five. Two calculi in upper third right ureter clearly seen causing bulging with secondary clubbing of calices above. Stones successfully passed six days later. Moderate ptosis also apparent causing ureteral kink.

ureteral calculi exactly alike. However, authors may give their views on the subject, and if their technique has been satisfactory in their hands, it may likewise be of some value to others.

In reviewing a considerable amount of literature on the subject, one is amazed by the tremendously high percentage of surgical operations performed for ureteral calculi. It strikes the writer as being far too high in this era of urology, with our present knowledge regarding cystoscopic procedures and ureteral manipulations. For example, Barney and Chute in the paper referred to here, have done a ureterolithotomy in 58.5 per cent of their cases. They state that 72 patients out of their series of 123 cases were operated on. In the series published herewith only 3 out of 77, or about 3.89 per cent, were operated



FIG. 12. Mr. H. G., aged twenty-three. Large calculus in lower left ureter successfully passed two days after ureteral dilatation. This case illustrated need of conservatism. Calculus is of size which might easily tempt one to perform open operation.

particular group of cases presented more difficulties than the series with the lower percentage of necessary open operations. On the other hand, as we visit clinics throughout the country, are we not often impressed by the hasty judgment of some operators? We watch with much interest a surgical demonstration of a ureterolithotomy for a small stone somewhere in a ureter, and do not some of us often wonder if this stone could not have been successfully passed without surgical intervention?

The problem of management, I believe, depends largely on the character of the colics in an individual patient, as well as on our ability to relieve the colics and consequently help the stone down its course in the ureter. The size of a given stone, most naturally, is an important factor. Stones which will require an opening in the ureteral orifice of 18 F or more, certainly are to be removed surgically. But the average stone is much smaller, and most of the stones small enough to



FIG. 13. Mrs. J. R. Large impacted calculus in lower third right ureter. Patient remained comfortable for two years, and was not seen again until recurring colics. Stone had not changed its position. This stone also removed successfully by ureterolithotomy.

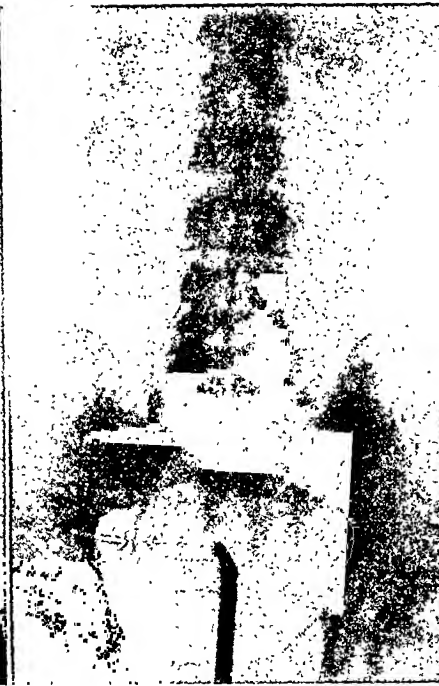


FIG. 14. Mr. A. F., aged twenty-five. Left urogram showing bulging in ureter at point where definite obstruction met. This case is of interest because the only complaint was that of painful aching in left testicle, associated with red cells in urine. There was also a 35 c.c. residual urine in renal pelvis. Stone was successfully passed five days after ureteral dilatation.



FIG. 15. Mr. P. C., aged fifty-two. Figure illustrates faint calculus shadow slightly above intramural portion on left side.



FIG. 16. Same case. Shows calculus with moderate ureteral dilatation above it. No. 9 bougie passed beyond obstruction with some difficulty. Stone passed following morning or twenty-four hours later.



FIG. 17. Mr. A. S., aged twenty-six. Plain x-ray film shows suspicious shadow in region of lower right ureter. History of tenderness and pain in lower right abdomen, which had on two previous occasions been diagnosed as appendicitis.



FIG. 18. Same case. Shows catheter up to stone. Also urogram demonstrates filling defect caused by stone, as well as dilatation above obstruction. Necessary in this case to slit ureteral orifice with cystoscopic scissors. Stone passed in twelve days after this procedure.



FIG. 19. J. S., aged fifty-two. Large wedge-shaped stone in left lower ureter occurring in physician. One of two cases reported in series in whom stones have not yet been passed.



FIG. 20. Same case. Left urogram showing well-marked filling defect of higher density caused by calculus in intramural portion of ureter. Note marked dilatation of lower ureter.

pass the orifice if it has been previously dilated sufficiently to allow it to fall into the bladder.

more portions of the routine which might bear reviewing. (Two patients still possess their stones.)



FIG. 21. Mr. E. H., aged thirty-five. Very severe left ureteral colic due to pea-sized calculus, as illustrated, in lower third left side. Dilatation and indwelling catheters followed by irrigation during their removal. Stone passed one week later without further colic.



FIG. 22. Mrs. B. F., aged thirty. Elongated type left ureteral calculus in lower third. Usual dilatation and two catheters indwelling for twenty-four hours. Removed during irrigation. This stone passed eight hours after removal of catheters.

Most urologists have had the experience of having been able to extract a stone from the ureteral orifice. In this series this procedure was "enjoyed" in 3 instances. These, however, are so unusual that it cannot be considered in the technical management. It is mentioned to illustrate one of the many diversities which confront the operator.

TECHNIQUE

It is difficult to outline any given rule regarding technique. However, in a series of 77 patients, 72 of whom were rid of their ureteral stones without operative surgery, it would seem that there must be one or

First: As stated in the beginning, a clinical diagnosis is attempted, guided by a careful history, the physical signs and the microscopic examination of the urine. Red blood cells are important. They occurred in 61, or 79 per cent of the series.

Second: Cystoscopy is planned, preferably while there is still renal tenderness present. The ureteral catheter or bougie is more apt to meet obstruction at this time, at the point where the stone is lodged. The finding of pelvic retention by syringe test is also of importance at such a time.

If a catheter is passed after the relief of colic, it may occasionally go beyond a stone without the slightest sense of obstruction. However, the technique of passing a catheter (No. 5 x-ray) should be carried out slowly and cautiously. Rapidity in

reaching the renal pelvis loses all the fineness of touch and sensation. It might be compared to one of our modern jazz-

can often be ascertained by withdrawing the residual pelvic urine by means of a syringe.

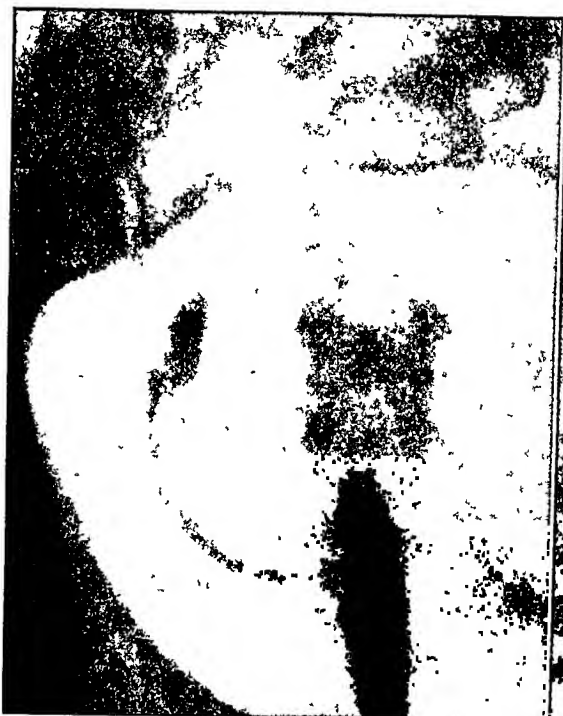


FIG. 23. Mr. R. T., aged thirty-eight. Large impacted right ureteral calculus. Impossible to pass a catheter beyond stone. History of colics on this side for past eighteen years. Operated.



FIG. 24. Mr. R. H., aged thirty. Calculous obstruction definitely met just above intramural portion on left side. Typical attacks of left ureteral colic associated with red cells in urine. Roentgenogram shows faint shadow of calculus as indicated. Usual treatment resulted in stone being passed four days after cystoscopic manipulations.

pianists trying to play Handel's Largo: he would simply miss the technical grace necessary in that particular composition. If one catheter has passed up successfully, then, and not until then, is an exposure made on a 14 × 17 in. film, using, of course, a Potter-Bucky diaphragm. The operator may then attempt to pass another No. 5 catheter. In a few instances, a second catheter has met obstruction at the stone, but in most cases two have been admitted successfully.

Third: The x-ray film should then be studied by the operator. The developing room near or directly off the cystoscopic room is almost as essential as the x-ray tube is over the examining table.

Fourth: If a shadow is demonstrable, one of the two catheters is plugged, and a urogram made; however, this is not always necessary. The degree of hydronephrosis

Fifth: If no shadow is found, and there is no reason to suspect a stone, the catheter is removed, and replaced with a larger Garceau or Woodruff catheter for the purpose of urography. Filling defects, bulging in the ureteral wall, plus history, plus the sense of touch and plus the previous findings of red cells, may be regarded as indicative of ureteral calculi. Some of the roentgenograms illustrate this point.

Sixth: A diagnosis having been made, two No. 5's are again passed up beyond the stone. No doubt there are some who will say, "Supposing the stone cannot be passed, will the ureter allow a catheter"? Then a heavy No. 8 or 9 olive-tipped bougie usually will pass. If one then attempts to introduce a catheter immedi-

ately after the removal of a bougie, it will most always pass. It may be necessary to draw it back and forth a few times, which,

have passed calculi within forty-eight hours after the removal of the ureteral catheters, and in most instances without



FIG. 25. Mrs. A. B., aged thirty. Right ureteral calculus. Calculus indicated by arrow. Note peculiar dilatation below stone as well as ureteral spasm above it. Also note marked distortion of upper ureter and renal pelvis.



FIG. 26. Mr. S. V., aged fifty-three. Large calculus in lower left ureter with tortuosity of ureter, and secondary hydroureter above obstruction. Usual dilatation by inlying catheters and irrigation during their removal. Patient passed stone five days after removal of catheters without further colics.

incidentally, has been of great value.

Seventh: The patient is then returned to his or her room in a recumbent position, and the catheters left in place for twenty-four, forty-eight, even seventy-two hours.

Eighth: Now, I believe, comes the important part in the procedure. As the catheters are about to be withdrawn, one is plugged (if two are in) and a 30 c.c. Luer syringe filled with sterile water and connected to the catheter. The kidney is filled slightly beyond the point when the patient feels the renal pressure. The catheter is *very slowly* withdrawn with one hand, while the syringe is held for injection in the other hand. Two forces are at work with this procedure: the traction caused by the downward motion of the catheter, plus the force from above, which in many instances accomplishes the desired purpose. Frequently, by this procedure, patients

any additional, or so called "final colic."

SUMMARY

1. A series of 77 cases of ureteral calculi are reported, in which 3 or 3.89 per cent required ureterolithotomy, 2 are still unpassed, and 72 or 93.5 per cent were passed successfully without open operation.

2. Diagnostic importance is made of the clinical history, the presence of red blood cells in the urine, and the cystoscopic and x-ray technique combined.

3. A method of removing the ureteral catheters during irrigation has resulted rather successfully in a rather high percentage of cases.

4. The use of ureteral spirals, forceps, rubber-bags, etc., has in no way added to the successful management of this series.

5. No mortalities occurred in this series.

AN ELECTROSURGICAL RONGEUR*

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ANY new instrument or advance in the technique of the treatment of malignancy is always welcome, particularly when dealing with extensive disease, especially involving bone. Within the past few years electrosurgery has stepped in to take a definite, unique place in the surgeon's armamentarium to assist in the fight against this dreaded disease. As with other new devices, electrosurgical apparatuses have evolved through years of laboratory and clinical experimentation and methods of application of the current have made steady progress.

The removal of malignant bone, whether involved by a tumor arising in the bone itself or in the surrounding soft parts, has, up to the present, been accomplished by radical resection with cold instruments which would in no way affect the growth, always running the risk of spilling cells into the clean wound, a fertile field for recurrences. With electrosurgery, however, malignant bone is attacked with no fear of dissemination as the tumor cells are destroyed by the onslaught of the heat generating current.

Obviously, the ideal electrosurgical current would generate a sufficiently high temperature at the point of contact to literally melt or oxidize the bone away before the advancing electrode. This is most difficult to realize, as a temperature hot enough to melt the inorganic lime salts in bone would probably also melt the metal of the electrode and destroy tissue at some distance from the line of incision. We are at present left with the application of the heat created by our usual electrosurgical currents by means of cutting instruments which will advance through the hard, inorganic bone, after destruction of inorganic contents.

With this in mind, I have been using a two-stage method, so to speak, in remov-

ing bone involved by malignant growth. First, the organic matter is destroyed as deeply as possible. The inorganic material is then rongeured away, down to live bone and again the coagulating current applied to destroy the living cells. Step by step large areas of bone are thus removed. When one is operating in this manner, it will be noted that as soon as the organic substances are thoroughly coagulated and dried out of the bone, the calcium salts become an insulator to further passage of current and very little, if any, sparks are visible. It is evident that this inorganic material must be removed before coagulation can be continued. This fact is an obstacle to be overcome before the development of any electrosurgical current which will actually cut through bone.

A few weeks ago, while resecting an extensive carcinoma of the face, overlying the zygomatic arch, I began to remove the arch in the manner just described. As the dead bone was being rongeured away, it occurred to me that time could be saved and the operation rendered more efficient by applying the active electrode carrying a strong coagulating current to the handle of the rongeur as it was passing through the bone. To my great pleasure I found that not only did this expedite matters, but the bone came away without hemorrhage. In the two-stage method described there always was a certain amount of bleeding after one had rongeured off the hard, dehydrated bone. With this rather cumbersome method of holding the electrode to the rongeur, I was able to resect the zygomatic arch and proximal portions of the malar bone with ease and efficiency. To facilitate the technique, I had a binding post fastened to the inside of the handle of the rongeur (Fig. 1). The wire from this binding post can be connected directly

* Submitted for publication May 16, 1931.

to the electrosurgical instrument, or spliced on to the wire reaching the active coagulating electrode, making it possible for the operator to pick up at will the rongeur or electrode, both of which are attached at the same time to the generator.

Since my first experience, opportunity has been afforded to use this electrosurgical rongeur in many otherwise difficult places. One of the most interesting was during the electrosurgical eradication of an extensive carcinoma of the right antrum. A large portion of the anterior and lower walls of the antrum was eroded by the growth, with much involvement of the malar bone and the floor of the orbit, as well as the medial wall of the antrum. A Fergusson incision was made and the check thrown back. The growth was then slowly and almost bloodlessly scalloped out with an electrosurgical loop down to the ragged bony walls. With the electrosurgical rongeur any involved bone needing removal was bitten off bloodlessly, leaving a dry, white, sterile surface. The ability to treat bone in this manner hastens the convalescence and healing of the wound, as more disease is removed and less bone left behind to sequestrate. It is gratifying to be able to destroy bone in this manner which otherwise could not be resected without spilling cells.

While using this instrument one must guard against any portion of the metal rongeur touching the patient except at the biting edge. This extra contact results in a short circuit, reducing the current strength therefore, between the jaws of the rongeur. It is possible that the back of the jaws could be insulated by painting with several layers of bakelite, although as yet I have found it unnecessary, it

being sufficient to hold the instrument away from surrounding tissues.

I venture to prophesy that such an

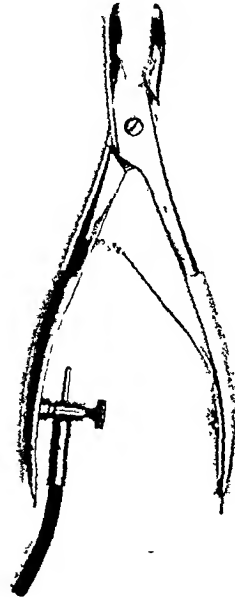


FIG. 1. Electrosurgical bone rongeur.

instrument would be of great assistance in neural-surgery, when uncontrollable bleeding occurs from vascular bone. Here it would be advantageous to slip a wooden tongue depressor beneath the bone preventing short-circuiting to brain tissue, unless one had an instrument insulated as suggested here.

In summary it is only necessary to say that an efficient electrosurgical bone rongeur has been devised by attaching a binding post to the usual form of rongeur for the connection of the cable from the electrosurgical generator. With this rongeur otherwise inoperable, malignant bone is removed in dead pieces without danger of metastasis.



THE CLINICAL MANAGEMENT OF THE HORSESHOE KIDNEY

Part II*

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VII. PATHOLOGY

The pathology of horseshoe kidney has been thoroughly discussed by various writers in the medical literature and it is beyond question that the anatomic predisposing factors of the anomaly serve to produce complications and to develop associated pathology. In fact, writers and investigators of the olden times and of the precystoscopic era, have amply demonstrated the common occurrence of pathological lesions of one sort or another in practically 9 out of 10 cases in specimens removed at post mortem.

We must, therefore, admit that all individuals who are born with a horseshoe kidney are potentially suffering with chronic horseshoe kidney disease, because sooner or later they will develop a certain degree of active or passive pathology with the characteristics of urinary stasis, recognized or unrecognized clinically, which will ultimately be definitely established.

For this reason we must consider in this study two essential groups:

I. The group of cases in which the associated pathology of a concomitant disease has been found before operation or during operation, where the surgical pathology has been well demonstrated.

II. The group of cases in which no gross pathology can be visualized, although there are enough clinical signs and symptoms to prognosticate the clinical conception of horseshoe kidney disease.

In 1922 Judd, Braasch and Scholl reported that in a series of 2424 operations performed on the kidney at the Mayo Clinic for various conditions, 17, or 1 in 142 cases, were on horseshoe kidneys and that most of the operations were for hydronephrosis, pyonephro-

* Part I appeared in the December, 1931, issue of the Journal, vol. 14, p. 657. Part III will appear in the February issue.

sis, renal stone or renal tuberculosis, as complicating one-half of the horseshoe kidney condition.

Eisendrath, Phifer and Culver in 1925 tabulated from the literature, together with the reference of each author, a long series of operations performed in cases of horseshoe kidney with various pathological lesions as follows: 12 cases of symphysiotomy or division of the isthmus for persistent abdominal pain due to the horseshoe kidney mass, 64 cases of heminephrectomy, 37 of pyelotomy or nephrotomy, 10 of primary pyelotomy or nephrotomy with secondary heminephrectomy, 2 of plastic operation or ureterolysis, 4 of subparietal injuries, and 8 miscellaneous cases, including the report of 3 of their own, making a total of 137 cases of horseshoe kidney, all associated with various types of surgical pathology.

Rathbun, in 1924, studying the clinical aspect of horseshoe kidney, analyzed from the literature 108 cases and records the pathology found in those cases as follows: Calculi 32, hydronephrosis 18, pyonephrosis 11, tuberculosis (one bilateral) 12, neoplasm 4, polycystic disease 3, nephritis 2, fistula 1, uncomplicated 13, no details 7, making, with the report of 3 cases of his own, a total of 108 clinical cases studied. These figures and material demonstrate the enormous frequency of this condition and its rôle as the paramount predisposing cause in the formation of associated pathological lesions. One may, therefore, conclude that pathology of any sort is more likely to be formed in an anomalous misplaced semicircular renal mass than in normal kidneys, particularly when the isthmus is thick, making pressure upon the aorta and vena cava across the midline, and when it is deeply adherent to the surrounding structures, incarcerated and without movement, thus naturally interfering with the dynamic or mechanical physiological power to secure drainage in the gland of maximum secretion.

The early clinical manifestations and etiological factors of symptomatic diseases and pathological changes have already been sufficiently discussed in the previous chapter. Only to emphasize the variety of the lesions and the unrecognized diagnoses of the past, we must, however, mention the astounding case reported by Boss and quoted by Papin in which a pelvic tumor diagnosed as a retro-uterine hematocele was surgically removed through the vagina and found later to be a horseshoe kidney with chronic nephritis, for which

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error the patient died of uremia. There is also the case reported by writers of the Mayo Clinic of a boy of eleven suffering with an abdominal mass which had been incised and drained three years previous to observation and had discharged freely ever since. After injection of the sinus the roentgenographic examination revealed a large hydronephrosis which at operation was found to be a horseshoe kidney.

The pathology found in our series of 25 cases of horseshoe kidney herewith reported must be classified in three groups: First, 19 cases diagnosed before operation, which were submitted to complete urologic and pyelographic examination. Second, 2 cases diagnosed at operation without urologic and urographic examination. Third, 4 cases that did not receive urologic or pyelographic examination and that were found at post mortem.

The pathologic lesions found in these cases are summarized in the following three tables.

TABLE I

PATHOLOGIC LESIONS FOUND IN 19 CASES OF HORSESHOE KIDNEY DISEASE DIAGNOSED BEFORE OPERATION

	Cases
Pyelitis and pyelonephritis infection with urinary stasis	3
Bilateral hydronephrosis	2
Unilateral hydronephrosis	1
Unilateral pyonephrosis	2
Renal tuberculosis	1
Stone, pyonephrosis, papilloma in renal pelvis and carcinoma in lower left pole	1
Nephrolithiasis	3
Bilateral nephrolithiasis	1
Stone in right ureter	1
Stone in bladder	1
Chronic nephritis	3
Total	19

TABLE II

HORSESHOE KIDNEY DISEASE DIAGNOSED IN 2 CASES AT OPERATION

	Cases
Chronic appendicitis	1
Exploratory laparotomy for undetermined abdominal tumor	1
Total	2

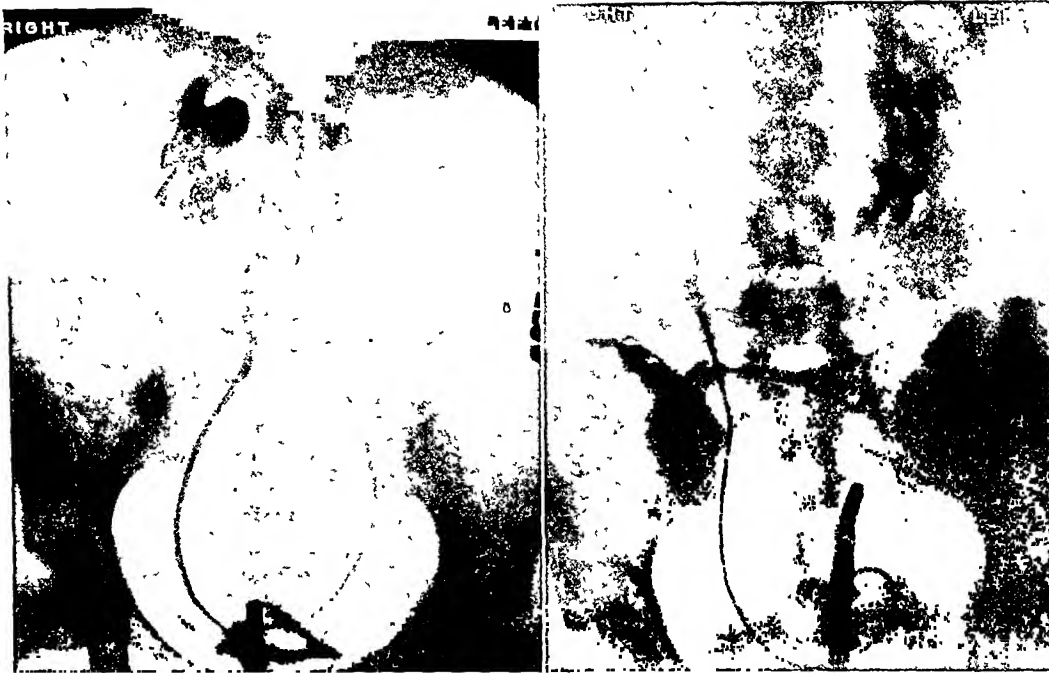


FIG. 12.

FIG. 13.

FIG. 12. Right pyelogram of Case XIII revealing a bizarre shape of pelvis with inward rotation and the lower calices pointing toward the midline, thus plainly revealing the presence of a horseshoe kidney.

FIG. 13. Left pyelogram of Case XIII, revealing the same internal deformity of the pelvis with two definite pelves, the upper one apparently normal and the lower one irregular with a long calix extending to the transverse process of the fourth lumbar vertebra and corresponding with the pyelogram of the opposite side, giving evidence of horseshoe kidney.

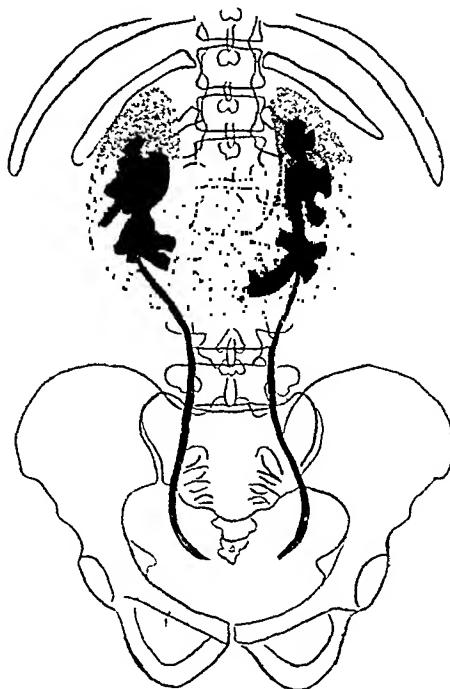


FIG. 14. Drawing from Figures 12 and 13 of Case XIII, representing the typical arrangement of the horseshoe kidney.

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TABLE III
PATHOLOGIC FINDINGS AND TYPE OF LESION IN 4 CASES OF HORSESHOE KIDNEY DISEASE
FOUND AT POST MORTEM

	Cases
Retroperitoneal lymphosarcoma, many metastases, marked emaciation, horseshoe kidney with three ureters and chronic nephritis.....	1
Aneurysm of arch of aorta. Luetic aortitis. Carcinoma of rectum. Adherent pericarditis. Kidneys fused by the upper pole and chronic nephritis	1
Carcinoma of stomach, dilatation of heart, generalized edema, hemorrhage of gastrointestinal tract, horseshoe kidney and chronic nephritis	1
Chronic endocarditis, chronic myocarditis, acute cystitis, hypertrophy of prostate, horseshoe kidney and chronic nephritis.....	1
<i>Total</i>	4

Résumé:

19 cases diagnosed before operation, all with various pathological lesions.

2 cases diagnosed at operation without urological examination.

4 cases encountered at post mortem without urological examination.

—
Total..... 25 Cases

The most striking feature of the pathologic findings, particularly in the group of autopsy cases, is the fact, never stressed before, that a microscopic study of the sections made in these horseshoe kidney specimens has uniformly revealed marked pathologic changes in the histologic structure of the renal parenchyma, giving evidence of chronic interstitial nephritis and glomerular and tubular nephritis, thus emphasizing the clinical characteristics of a new medical entity that should be recognized as the horseshoe kidney disease.

These facts have been abundantly demonstrated by the pathologists of the New York Hospital, as can be seen in the summarized report of the cases.

VIII. SYMPTOMATOLOGY

In horseshoe kidney disease the signs and symptoms have no absolute pathognomonic significance, particularly in our days when the diagnosis must be based on roentgenographic and pyelographic findings. However, the history of the patient and the findings of a good preliminary physical examination must always be of great clinical value in establishing a tentative diagnosis or in reaffirming



FIG. 15.

FIG. 16.

FIG. 15. Left pyelogram of Case xvi disclosing the presence of a much dilated pelvis with a peculiar inward rotation, suggesting the presence of a horseshoe kidney. Notice that the catheter reaches the pelvis in an unusual angle and from behind.

FIG. 16. Bilateral pyelogram of the same case showing marked hydronephrosis of the retentive type on the left side. The right pyeloureterogram reveals the unusual position of the ureter and the inward rotation of the pelvis and lower calices, both in contact with the shadow of the vertebral column, thus confirming the presence of a horseshoe kidney.

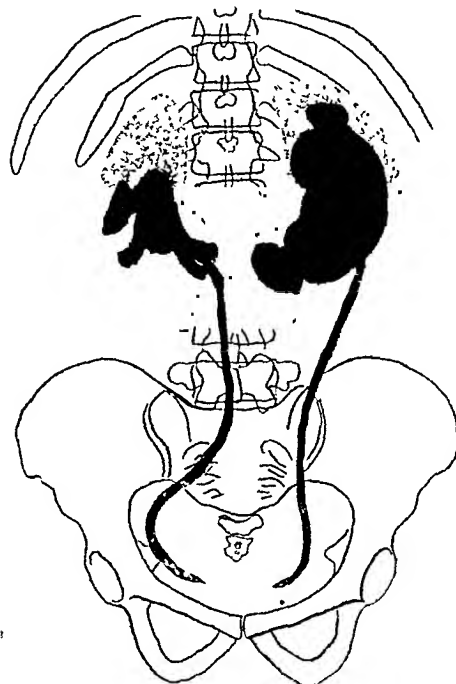


FIG. 17. Illustrative drawing from pyelograms of Figures 15 and 16, showing the typical arrangement of the pelves and ureters in the horseshoe kidney.

such diagnosis before or after any urographic procedure is undertaken. Moreover, as the kidney condition is a congenital one, which may or may not be recognized clinically in the young adult or at birth, signs and symptoms might not develop until later on in life when an accident occurs or a complication from a general disease or a secondary infection sets in. Therefore, in this condition, no final diagnosis will ever be correct and accurate unless it corresponds with the clinical condition of the patient.

Nevertheless, the signs of horseshoe kidney may be manifold and of great variability, according to the anatomic type, the structure, size and position, as well as the degree of the chronic or acute condition present in the anomalous organ.

In the true, symmetric and most common type of horseshoe kidney, which is the one discussed here, the most characteristic signs must be divided into two groups: (a) the normal horseshoe kidney apparently without clinical signs or symptoms and (b) the pathogenic horseshoe kidney with associated or concomitant pathology.

In lean patients or in individuals who have just had a good bowel movement, the isthmus or the somewhat anterior lower right or left pole of the horseshoe kidney may be readily palpable during deep inspirations. This, however, is not a constant finding and in our series of 25 cases the abdominal renal tumor mass was suggestively palpable in only 7 or 28 per cent of the instances. But preoperative diagnosis of horseshoe kidney has been made by palpation alone in cases with combined pathology by Israel, Albarran, Martinow, Rovsing and half a dozen other surgeons of those days, who remembered the dictum, established first by Israel, that "the surgeon must bear in mind the possibility of such a congenital kidney malformation." A palpable tumor mass in the area of the umbilical region must be strongly suggestive of horseshoe kidney as must also a palpable mass revealed by rectal or vaginal examination when associated with urinary or gastrointestinal disturbances. As a rule there is a long history of complaints in association with the alternating attacks of clinical symptoms. I have tabulated these signs and symptoms in this series of 25 cases in the order of their frequency, and perhaps of their importance, as they have been observed.



FIG. 18. Bilateral pyelogram of Case IX, revealing the peculiar arrangement of both pelvises with inward rotation and with lower calices pointing toward the midline, thus establishing the presence of horseshoe kidney disease. Note that the angle in which the ureters reach the pelvises plainly interferes with the normal drainage.

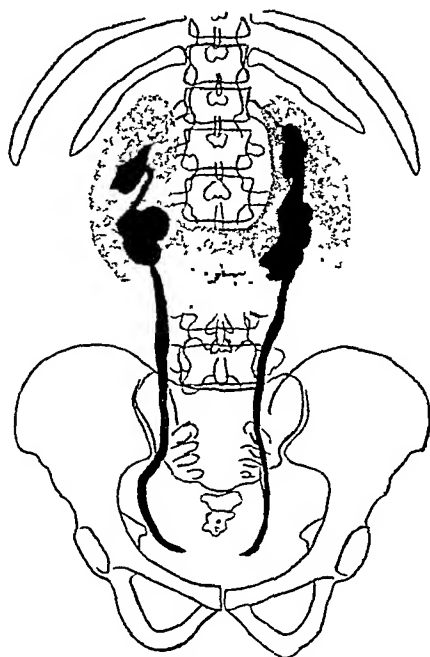


FIG. 19. Drawing from bilateral pyelogram of Figure 18 showing the high implantation of the ureters and the peculiar arrangement of the pelvises and lower calices, which gives evidence of horseshoe kidney disease.

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TABLE IV
SIGNS AND SYMPTOMS IN 25 CASES OF HORSESHOE KIDNEY DISEASE IN ORDER OF FREQUENCY

	Cases
1. Abdominal pain in all Distributed as follows. Pain in epigastrium Pain in umbilical region Pain radiating across back Pain radiating to right lumbar region Pain radiating to left lumbar region Pain in right upper quadrant Pain in right lower quadrant Pain in left lower quadrant Lumbago Indefinite abdominal pain	25
2. History of chronic constipation	24
3. Urinary disturbances	23
4. Signs of nephritis	22
5. Pollakiuria	21
6. Albuminuria	20
7. Cloudy and hazy urine	19
8. Dysuria	18
9. Gastrointestinal disorders, vomiting, nausea, etc	15
10. Pyuria	18
11. Chronic cystitis	12
12. Nocturia	10
13. Hematuria	8
14. Bacilluria	8
15. Compression and difficulty in respiration	8
16. Bladder tenesmus	7
17. Chills and fever	7
18. Uremia	6
19. General anemia, fatigue, weakness	6
20. Cyanosis and edema of extremities	5
21. Rectal tenesmus	4
22. Signs of myocarditis and endocarditis	4
23. Pain in testicles	3
24. Pain in precordial region	3
25. Pain in midline when standing or walking	3
26. Anuria	3
27. Retention of urine	2
28. Varicocele	2
29. Pain in perineum	2
30. Phlebitis of both legs	2
31. Rheumatic pain on lumbar column.	2
32. Aneurysm of aorta	1
33. Arthritis of spinal column...	1

Résumé

1. In only 7 (28 per cent) of the 25 cases of horseshoe kidney was the renal tumor mass palpable.
2. The horseshoe kidney syndrome was present in 24 of the 25 cases (96 per cent).
3. The duration of symptoms varied from birth to thirty years or more.

The most characteristic point in the clinical symptomatology and probability of horseshoe kidney is the presence and constancy of the *horseshoe syndrome*, characterized mainly by (a) abdominal pain about the epigastric or umbilical region, (b) a history of chronic constipation associated or not with gastrointestinal disorders and (c) urinary disturbances with early signs of chronic nephritis. These three important clinical factors of the horseshoe syndrome have been observed in 24 of the 25 cases of this series, or in 96 per cent, and must clinically constitute the real basis for the diagnosis of horseshoe kidney disease.

Other signs and symptoms are outlined in Table IV which, although important, have not been so constantly checked up, mainly owing to the difficulty involved in following up clinic patients who have not been admitted to the hospital or who have not responded to the follow-up clinic after being discharged from the same, and also because other symptoms are mere complications resulting from the pathology already established. All in all, the enormous variety of urinary symptoms and of functional disorders due to compression and lack of blood circulation has dominated the picture and constitutes the chief complaint for which the patients have been referred for complete urologic examination.

Of the 19 cases which were correctly diagnosed preoperatively by urologic or urographic examination, some were acutely ill with pyelonephritis and possible uremic symptoms for lack of a correct diagnosis and proper treatment; others were suffering with renal colic due to the presence of calculi. Most of them were young individuals between twenty and forty years of age, who walked in with kidney pain and symptoms of nephritis, pyelitis and pyelonephritis or chronic cystitis, while others came only because of the persistence of albuminuria, microscopic hematuria, pyuria or hazy or cloudy urine with slight pollakiuria, which had been interpreted erroneously in association with the unrecognized horseshoe syn-

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drome. All of these cases were fundamentally due to lack of renal drainage, and ultimately on examination revealed the presence of horseshoe kidney disease.

TABLE V
INCIDENCE OF AGE AND SEX IN 25 CASES OF HORSESHOE KIDNEY DISEASE

Years	Cases
10 to 20	1
20 to 30	6
30 to 40	8
40 to 50	5
50 to 60	4
60 to 70	1
	—
Total	. 25
	Cases
Male	. 17
Female	. 8
	—
Total	25
	Years
The Youngest	. 18
The Oldest	. 66
Average Age	. 30

IX. DIAGNOSIS

In the clinical management of horseshoe kidney the most important consideration is to establish a correct diagnosis and then to adopt the proper treatment to relieve the pathological condition.

The preoperative diagnosis of this disease has been in the past one of the most difficult problems in surgical urology and one which, until the introduction of pyelography and the urographic examination, it has been practically impossible to solve. In fact, this is the reason that a relatively small number of horseshoe kidneys have been correctly diagnosed preoperatively up to the present time and that before the era of pyelography nearly all the statistics and cases reported were based on autopsy findings.

The misleading clinical symptomatology of an acute, subacute or chronic abdominal condition, when the surgeon does not bear in mind the possibility of a congenital kidney malformation, has led to a vicious circle of erroneous diagnoses, one following another, and also to many needless abdominal operations.



FIG. 20. Left pyelogram of Case 11, revealing an enormous infected hydronephrosis with greatly dilated pelvis and calices turning inward, showing the presence of a horseshoe kidney with acute symptoms. This patient was treated successfully with an indwelling ureteral catheter.

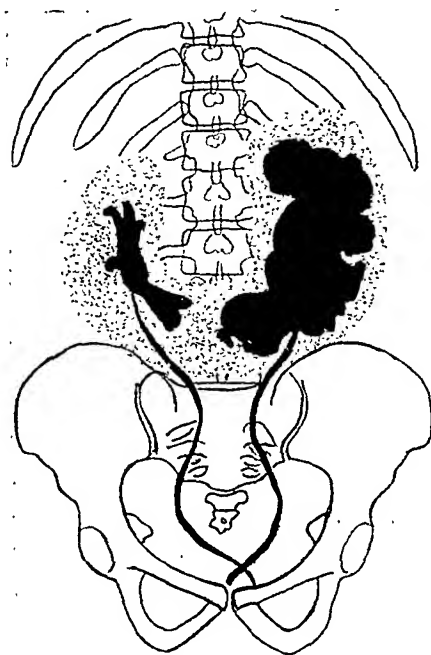


FIG. 21. Drawing of same case demonstrating the position of pelvis and lower calices extending into the isthmus of the horseshoe kidney.

The problem of differential diagnosis without a complete urological examination was never accurately solved, and from time immemorial, with very rare exceptions, horseshoe kidney when clinically observed has been erroneously diagnosed as some other abdominal condition, owing to the misleading early signs and symptoms. Among the most common of these erroneous diagnoses have been acute or chronic appendicitis, gallstone attacks, duodenal ulcer, acute pancreatitis, chronic ulcerative colitis, tumor of the head of the pancreas, tumor of the colon, gastric ulcer, neurasthenia, renal colic, arthritis of the spinal column, indefinite abdominal pain and chronic constipation, paralytic ileus, and undetermined abdominal tumor, while some cases of horseshoe kidney have been relegated to the group of unclassified diagnoses.

Of our series of 25 cases, every one had been previously examined in some other hospital and by various doctors and specialists by whom many contradictory and erroneous diagnoses appear to have been made.

Previous to the establishment of the diagnosis of the actual horseshoe kidney disease, 12 patients of this group of 25 (48 per cent) had been operated upon elsewhere for various abdominal conditions, without obtaining curative or even symptomatic relief.

Hence it is seen how great is the difficulty of reaching a diagnosis without urographic examination, a difficulty so overwhelming that it has amounted to a practical impossibility even in the hands of the most skillful surgeons, to whom it has presented a major surgical engima.

Thus Rathbun, in a study of 108 clinical cases reported in the literature up to January, 1924, found that in only 24 cases (22 per cent) was the diagnosis made before operation, and that the remaining 84 cases were recognized for the first time at operation.

In a report of 16 operative cases by Judd, Braasch and Scholl, published in 1922, in only 8 cases was the diagnosis made previous to the operation. In only 50 per cent, therefore, of the instances did the surgeon know in advance that he was to deal with the difficulties of a horseshoe kidney operative procedure. Löffler in 1924 in studying the operations performed on horseshoe kidney collected 108 cases, in only 12 (11 per cent) of which had the correct diagnosis been made previous to operation.



FIG. 22.

FIG. 23.

FIG. 22. Case xvii, a female patient who came to the arthritis clinic of the Hospital for the Ruptured and Crippled with pain across her back and who has been receiving treatment for arthritis of the spinal column. The left pyelogram reveals a bizarre shape of pelvis with inward rotation and lower calices pointing forward and toward the midline, which plainly reveals the presence of a horseshoe kidney.

FIG. 23. Case xvii, right pyelogram revealing a "bottle neck" ureteropelvic junction with an excavation of one of the middle calices and inward rotation of the lower calices, which, with the corresponding pyelogram of the opposite side, confirmed the diagnosis of horseshoe kidney disease.

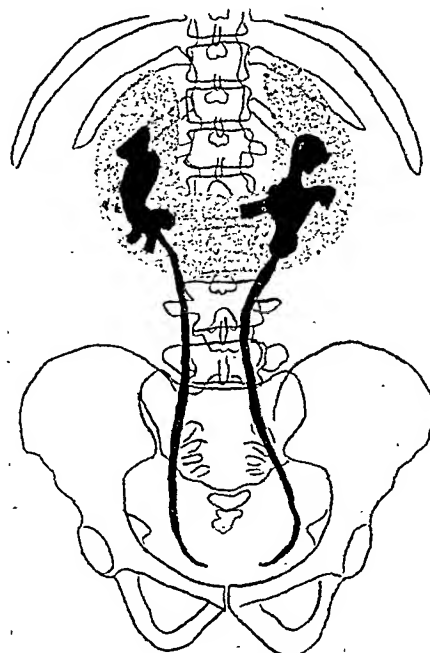


FIG. 24. A drawing from the pyelograms of Figures 22 and 23, illustrating the close relationship of the anomalous organ to the vertebral column and the forward and inward rotation of both pelves, attracted into the isthmus of the horseshoe kidney.

Undoubtedly with the introduction of the popular new method of intravenous pyelography more cases will be discovered in future, and what was a "rare curiosity" in olden times will be familiarly recognized as the new clinical entity, the horseshoe kidney disease, which will accordingly be found more frequently than has been the case in the past. Accuracy in the diagnosis will then be maintained in 100 per cent of the cases, such as we have already obtained in our series of 19 cases examined urologically and urographically and here reported.

To Braasch and his co-workers of the Mayo Clinic must go the credit for having called attention to the value and necessity of pyelographic data in revealing the presence of horseshoe kidney.

To establish a clear-cut and definite differential diagnosis in the routine clinical examination of any of the pathological lesions of the upper urinary tract, particularly when suggestive possibilities of fused kidney or horseshoe kidney disease may be under discussion, we must study any given case thoroughly and completely from various points of view, taking into account the following items:

1. History and subjective symptoms
2. Physical examination and objective signs
3. Urinary analysis
4. Blood chemistry
5. Roentgenography
6. Cystoscopy
7. Catheterization of the ureters
8. Renal functional test.
9. Urography
 - (a) Instrumental pyelography
 - (b) Intravenous pyelography
10. The horseshoe kidney pyelographic triangle

1. *History and Subjective Symptoms:* The value of taking a good clinical history cannot be over-emphasized, since in this series of cases the chief complaint has been of many years' duration, and I have the impression that the patient in many instances, in describing his sickness, points out the high lights of a subjective diagnosis. The objective and subjective symptoms taken together may be of the highest value in suggesting the diagnosis, because the *horseshoe*

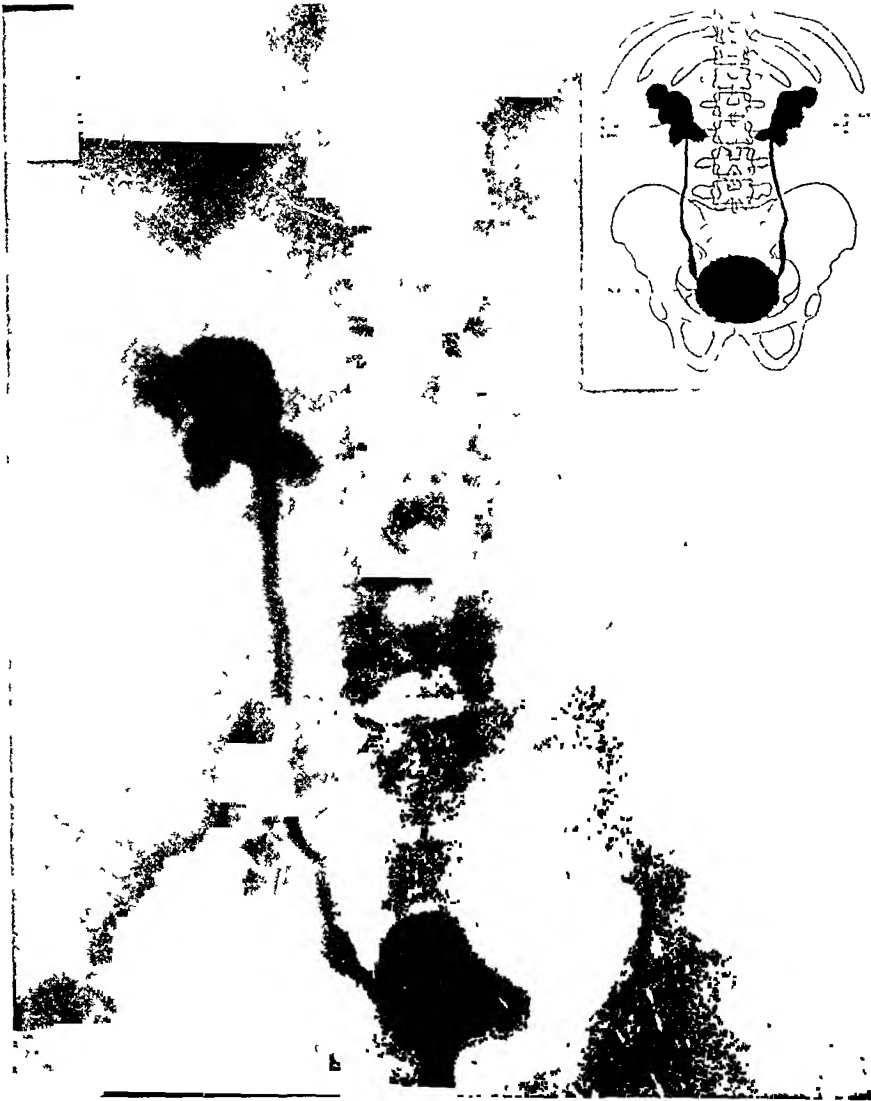


FIG. 25. Right pveloureterogram of Case X revealing an unusual shape of pelvis with inward rotation, and calices reversely placed, showing shaginess and distortion throughout. This together with the presence of the tubercle bacillus in the urine confirmed the diagnosis of tuberculous horseshoe kidney.

In the right upper angle is a drawing of the same case, showing the clinical findings with the pathological lesions present in this case.

syndrome has a definite bearing and has been most constantly observed in this group of cases.

The persistent or intermittent attacks of abdominal pain localized in the area of the epigastric and umbilical regions and radiating to both lumbar regions are most characteristic and have already been discussed in the chapter on etiological factors. This pain may be very severe, rather acute, subacute, or chronically present, and may extend across the back or radiate to the rectum, bladder or legs, particularly on standing or walking. Later on there may be evidence of poor circulation in the lower extremities caused by the constant pressure of the renal isthmus upon the great abdominal vessels. In more than a few cases these clinical manifestations are on record, showing lack of blood circulation and causing general weakness, anemia, edema and cyanosis of the lower limbs. Other subjective symptoms that may corroborate the presence of horseshoe kidney disease are summarized in Table iv.

Rovsing has described a sign which he considers of pathognomonic value in the early diagnosis, as follows: when the patient is standing and a contraction of the muscles of the lumbar region is made, combined with the bending backward of the vertebral column, a characteristic pain is said to be produced, which disappears when the patient is lying on his back. This sign has been observed several times in our series of cases, but has not been of any particular diagnostic value, possibly owing to the fact that it has not always been accurately checked up.

Summing up, the history of the clinical ensemble of horseshoe kidney embraces three outstanding features: (1) undetermined abdominal pain in the area of the epigastrium or umbilical region toward the flanks or the lumbar regions; (2) chronic constipation; (3) urinary disturbances.

2. *Physical Examination and Objective Signs:* The physical examination is of great importance because it may reveal concomitant lesions or functional disorders not only of the urinary apparatus but also of the respiratory, circulatory and gastrointestinal tract. In thin persons a fused kidney may be readily palpable. The renal tumor mass when displaced anteriorly in the abdomen in the area of the umbilical region can in some cases easily be made out on deep palpation and during inspiration. Also the degree of fixation and

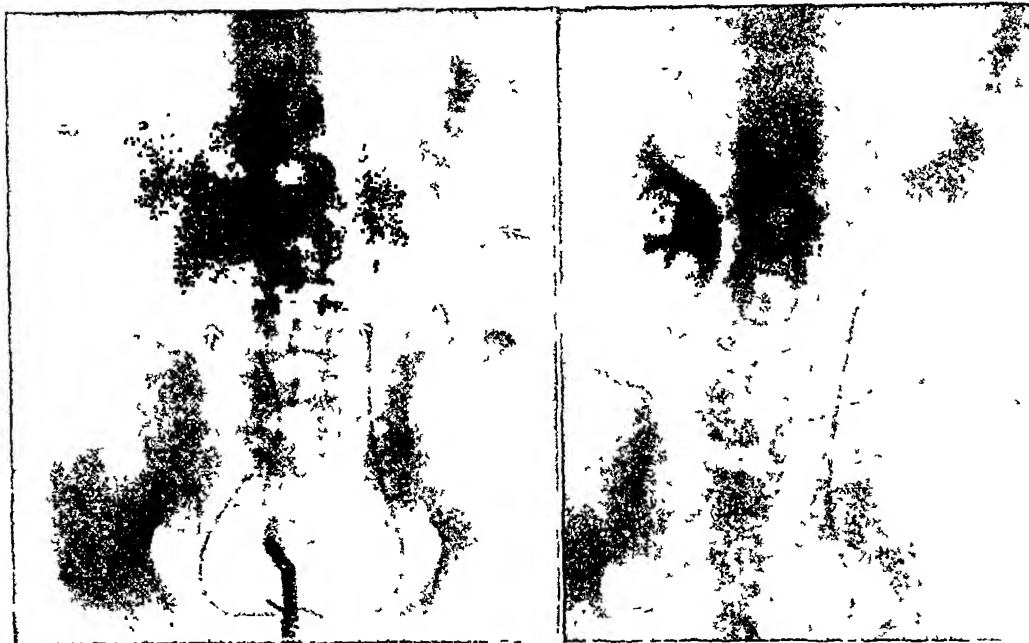


FIG. 26.

FIG. 27.

FIG. 26. Plain roentgenogram of Case xiv showing a very exceptional case in which the urographic findings did not correspond with the roentgen ray findings. The x-ray picture reveals an enormous horseshoe renal shadow extending across the midline to both kidney regions, thus representing a clear-cut view of a horseshoe kidney, which is also confirmed clinically.

FIG. 27. Right pyelogram of the same case, showing nothing more than a bifid pelvis, slightly dilated, close to the shadow of the vertebral column, but otherwise normal in shape and position.

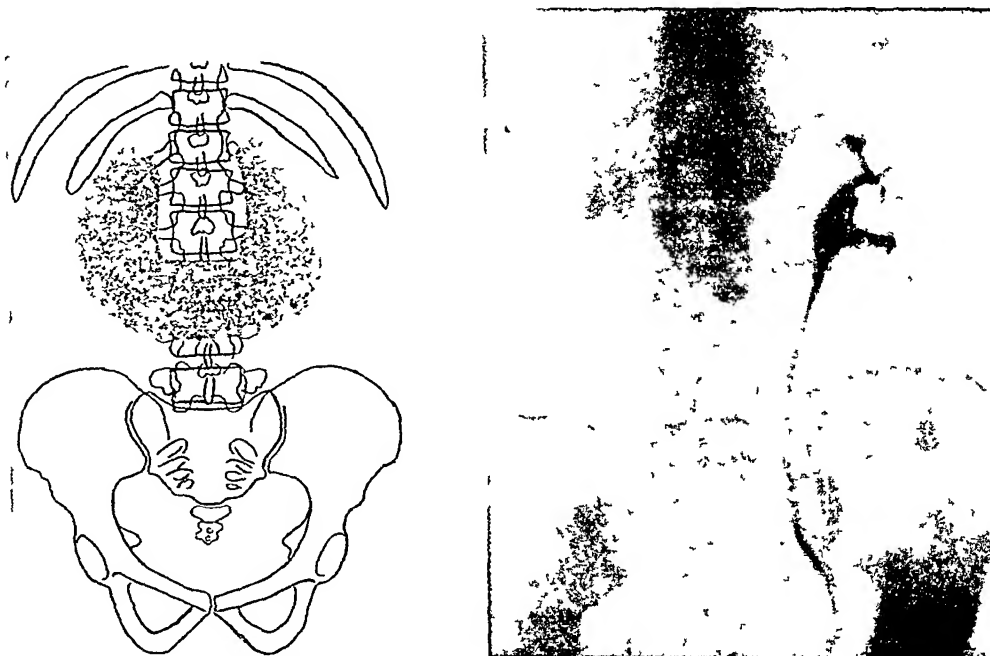


FIG. 28.

FIG. 29.

FIG. 28. Schematic drawing of horseshoe kidney of Case xiv as seen in the plain roentgenogram of Figure 26. Clinically the horseshoe kidney syndrome is abundantly present and therefore confirms the x-ray diagnosis of horseshoe kidney disease.

FIG. 29. Left pyelogram of the same case, revealing a normal kidney pelvis with normally placed calices and giving no hint urographically of a horseshoe kidney revealed by the plain roentgenogram.

irregularity of the contours of the lower poles on one or both sides may sometimes be noticed, when they can be followed into the mid-line where they constitute the supposed isthmus of a transversely placed renal bridge which unites one side to the other. In cases of marked dystopia, bimanual palpation combined with recto-abdominal or vaginal palpation has been of diagnostic value in several instances. In obese patients, however, palpation and physical inspection might result in negative findings. The pulsations of the abdominal aorta may be more accentuated both on abdominal palpation and on auscultation, owing to the pressure and tightening of the renal isthmus upon the great vessels.

The area of persistent pain in the umbilical region and epigastrium, where the solar plexus lies, may give a distinct flat note on percussion, as a characteristic sign of a possible solid renal isthmic mass of retroperitoneal tumor, in contrast with the rest of the abdominal wall which on percussion gives a tympanitic sound.

In acute conditions of pathologic horseshoe kidney, when the horseshoe syndrome is characterized by extreme bowel constipation, severe abdominal pain, chills and fever and urinary stagnation, due mainly to lack of drainage and to an intense degree of pyelonephritis and perinephritis, the muscles of the abdominal wall and of the lumbar region may be so firmly contracted by reflex defensive action that the revelation of abdominal signs is obviously impossible. In our own series of 25 cases the renal mass was suggestively palpable in only 7 cases or in 28 per cent of the total series. In addition other kinds of objective and subjective data can be obtained as for example in the case of patients who have been operated on previously for the drainage of a so-called anterior abdominal abscess, and who later complain of urinary sinus about the midline as the result of incision into a hydronephrotic sac of an anteriorly situated and unrecognized horseshoe kidney, an incident which has been reported by various writers, and which should lead us to look for further evidence of fused kidney before operating.

3. *Urinary Analysis:* In the majority of instances the chief complaint for which patients are referred for urological examination consists in the early urinary symptoms. Frequency of urination, difficulty, hesitancy, dribbling, pyuria, hematuria, nocturia and cloudy or hazy urine, etc., as premonitory signs and symptoms of a



FIG. 30.



FIG. 31.

FIG. 30. Right pyeloureterogram of Case VIII, revealing two pelves uniting in a common ureter with slight inward rotation, suggesting the presence of a horseshoe kidney.

FIG. 31. Left pyeloureterogram of Case VIII, showing a complete duplication of ureters and pelves. Note that the lower pelvis is turned inward and that the upper and lower calices of the same pelvis also extend inward toward the midline, revealing, therefore, with the pyelogram of the opposite side, the clear picture of horseshoe kidney disease.

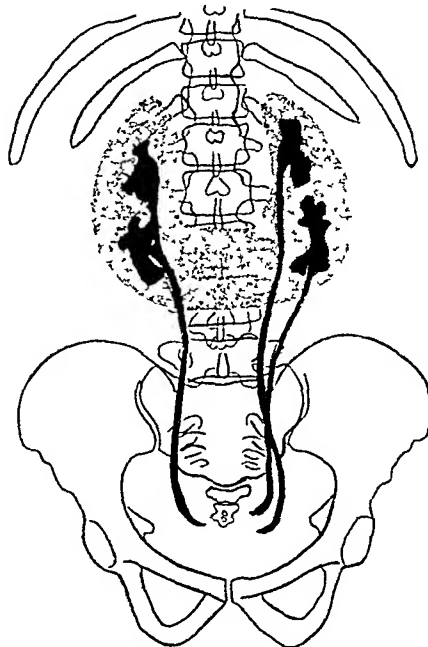


FIG. 32. Drawing from pyelogram of Figures 30 and 31 of Case VIII, showing the presence of four pelves and four incomplete ureters in the same case, demonstrating therefore, what may be called an anomaly of an anomalous horseshoe kidney.

suspected chronic or acute nephritis, pyelonephritis or cystitis, are among the very early clinical manifestations, which direct the attention to the necessity of a complete clinical urinalysis leading to a final diagnosis.

Many of our patients in this series of cases complain also of dull pain in the abdomen and persistent and undetermined attacks of renal colic, of albuminuria and microscopic pyuria and hematuria. Sometimes a laboratory urinalysis reveals the presence of bacterial infection, epithelial renal cells and various kinds of casts which point to the possibility of a true renal lesion, due in many instances to the presence not only of the horseshoe kidney disease, but also of a gross associated pathology that demands further investigation with a complete urological examination in order to establish a conclusive diagnosis. The value of this examination can be readily seen in a series of cases herewith reported, especially in Case xv, in a man fifty-seven years of age, in whom, with no serious clinical manifestations, the urographic diagnosis disclosed the presence of a horseshoe kidney with stone in the left renal pelvis together with pyonephrosis. Heminephrectomy was done and in the pathological specimen removed there was found a papillomatous growth in the renal pelvis, and in addition a tumor mass, carcinomatous in origin, occupying the lower pole of the same half of the organ. This indeed emphasizes the importance of an early and complete urological examination and establishment of the proper treatment (see Figs. 45 to 50).

4. *Blood Chemistry:* In horseshoe kidney the blood examination is ordinarily normal, but in disease it is possible that examination of the blood pressure, blood count and blood chemistry may bring out important clinical facts which will be of value not only for reaching a diagnosis but also for establishing a better prognosis in critical conditions.

It is assumed that the circulatory system will be somewhat disturbed in chronic horseshoe kidney disease. The myocardium undergoes certain degenerative changes due mainly to the extra demand made upon the muscle in response to the pressure of the isthmus of the horseshoe renal mass upon the abdominal aorta, causing in some instances hypertrophic myocarditis, endocarditis, aortitis, aneurysm and lack of circulation, as has already been



FIG. 33.

FIG. 34.

FIG. 33. Bilateral instrumental pyelogram of Case III, revealing the characteristic inward rotation of the pelves and calices, together with the "flower vase" position of ureters in horseshoe kidney. Notice that owing to the high implantation of the ureters there is lack of drainage with urinary stasis, pyelitis and pyelonephritic infection, which plainly reveals the presence of horseshoe kidney disease.

FIG. 34. Intravenous uroselectan pyelogram of the same case taken twenty minutes after the injection, which shows fairly good excretion of the drug and by its peculiar shadow-cast of the inward rotation of the pelves and lower calices forms a narrow pyelographic triangle, revealing the presence of a horseshoe kidney. Also note a distinct shadow about the size of a small pea at the right lower ureter and at the level of the second sacral foramen contrasting with the shadow of the distended bladder.

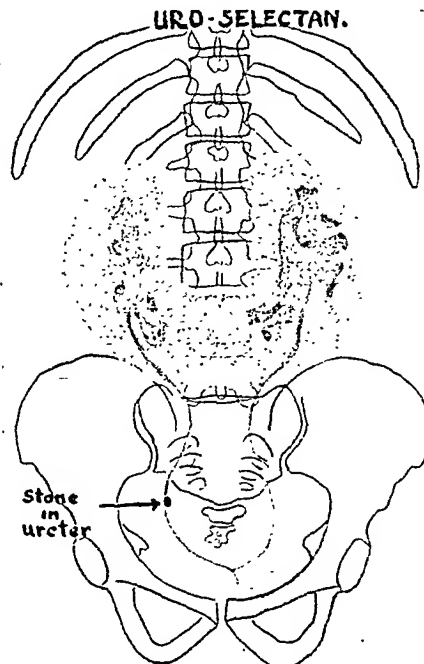


FIG. 35. Drawing from the uroselectan pyelogram of Case III revealing a stone in the lower right ureter and the "flower vase" shape of the ureter with the peculiar inward rotation of the pelves and lower calices into the isthmus of the horseshoe kidney.

stated. These organic and functional conditions have been fully checked up both in vivo and in the cadaver and particularly in the four autopsy cases herein reported. Clinically, as in any other renal conditions where infection, back pressure and urinary stasis are present, the blood pressure is high and the blood picture reveals anemia and marked leucocytosis. But in urological conditions the most characteristic and valuable blood findings are those relating to the blood chemistry, especially in the early stage of renal inability to excrete the toxic products of metabolism. These facts have been observed clinically in most of the cases, although the routine mode of examination here outlined was not carried out in all of them. Case xii is particularly illustrative in this connection.

The patient was a young man, twenty-two years of age, who on August 27, 1925, came to the hospital acutely ill, complaining chiefly of pain in the left kidney region and severe pain in the rectum. Physical examination revealed a very rigid and contracted abdomen. Blood pressure, systolic, was 210, diastolic 110, and the blood chemistry showed urea retention up to 167.90 mg. per 100 c.c. blood, against 18 to 21 mg. per 100 c.c. which is the normal figure. On routine urological examination the presence of a horseshoe kidney was diagnosed. The condition of the patient after slight improvement became aggravated and on September 3 the blood urea ran as high as 261.28 mg. per 100 c.c., while the creatinine retention went up to 7 mg. per 100 c.c. blood, presaging a fatal outcome. The patient died three days later in acute uremia, due probably to the horseshoe kidney disease.

5. *Roentgenography*: In the routine examination of the patient the roentgenographic shadows observed in an x-ray film may give the first hint of the presence of horseshoe kidney. The delineation or outline of the organ when visible and the unusual proximity of one or both kidney shadows to the spinal column, sometimes overlapping it and covering the line of the psoas muscle, is of significance for the suggestive diagnosis. The data thus obtained are of great assistance, although the outline of a fused kidney by the roentgen ray alone, is seldom sufficiently distinct to permit accurate interpretation. However, in some instances when the patient has had a good bowel movement and there is no gas or intestinal meteorism, the two halves of the kidney can be seen in a good x-ray plate lying very close to each other, one of them possibly nearer to the spinal column than the other, with their inner borders placed vertically and parallel to the column and to one another. But in only one case of this series did the roentgen ray alone lead to a positive diagnosis



FIG. 36.



FIG. 37.

FIG. 36. Right pyeloureterogram of Case XI, revealing an abnormal shape of pelvis with marked inward rotation and the lower calices extending toward the vertebral column, in a patient who has been operated upon for chronic appendicitis without symptomatic relief and who is in reality suffering with chronic horseshoe kidney disease.

FIG. 37. Left pyelogram in the same case revealing an unusual type of bifid pelvis with marked inward rotation, in which the lower calices extend transversely toward the midline, and which, with the pyelogram of the opposite side, brings out the very narrow space in the renal isthmus between the two lower calices, suggesting the formation of a *minimum angle of the horseshoe pyelographic triangle* (see text).

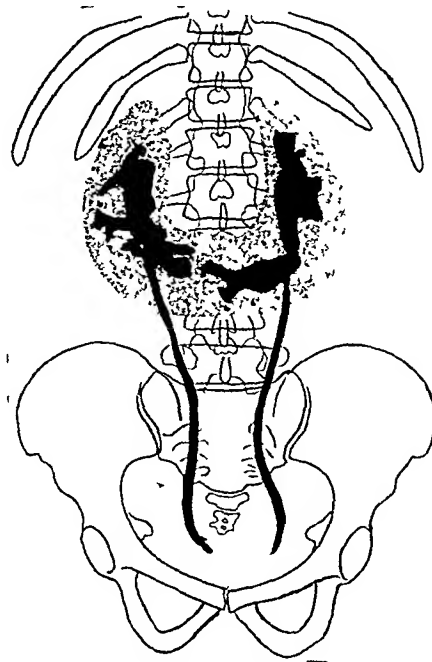


FIG. 38. Drawing from right and left pyelogram of Case XI showing the marked horizontal extension and close approximation of the two lowermost calices, leading to the recognition of a very characteristic sign, the extremely narrow *horseshoe pyelographic triangle*, of distinct pathognomonic value (see Figs. 39 and 40).

of horseshoe kidney, the renal shadow and outline of the isthmus of a horseshoe mass being clearly observed (Case xiv). The case is particularly interesting in view of the fact that here the bilateral pyelogram revealed negative findings, in that the two pelves and their calices were normally placed and without rotation, thus constituting a very rare instance and one that we may call a pyelographic anomaly of a horseshoe kidney, in other words *an anomaly of an anomaly*.

So far as the writer knows, this is the first instance of a roentgenographic diagnosis of a horseshoe kidney being made in a case in which the pyelographic evidence was negative. This patient has been reexamined recently, and is clinically and symptomatically suffering with horseshoe kidney disease. These findings appear to correspond with the case reported by Boeckel of Strasbourg before the annual congress of the Association Française d'Urologie in 1929, in which, with a normal bilateral pyelogram, this author found to his surprise at operation for renal lithiasis a horseshoe kidney with the pelves ventrally situated, for which reason he did an anterior pyelotomy for removal of the stone.

Furthermore, whenever roentgen ray shadows of renal calculi are seen lying in a transverse or oblique position and extending toward the midline or in contact with the vertebral column, they are strongly suggestive of renal fusion. Three such cases occurred in this series. Case iv, in a man who had been suffering for over twenty years with bilateral nephrolithiasis is illustrative of this type and is reported herein through the courtesy of Dr. Hernandez of Havana (see Figs. 7 and 8). Associated pathology was also detected in the roentgenograms, stone in the ureter and stone in the bladder being found in 2 cases of horseshoe kidney disease. In 4 instances an indefinite shadow of the isthmus of the horseshoe organ aroused suspicion and was definitely outlined on pyelographic examination. There are many other conditions which may mislead in the diagnosis, such as extraurinary shadows cast by calcified paravertebral lymphatic glands, stone in the upper ureter, low or median gallstones, calcified appendix or calcified tuberculous ovaries, all of which must of course always be clarified by a roentgenogram combined with an opaque x-ray ureteral catheter *in situ* or with urographic examination.

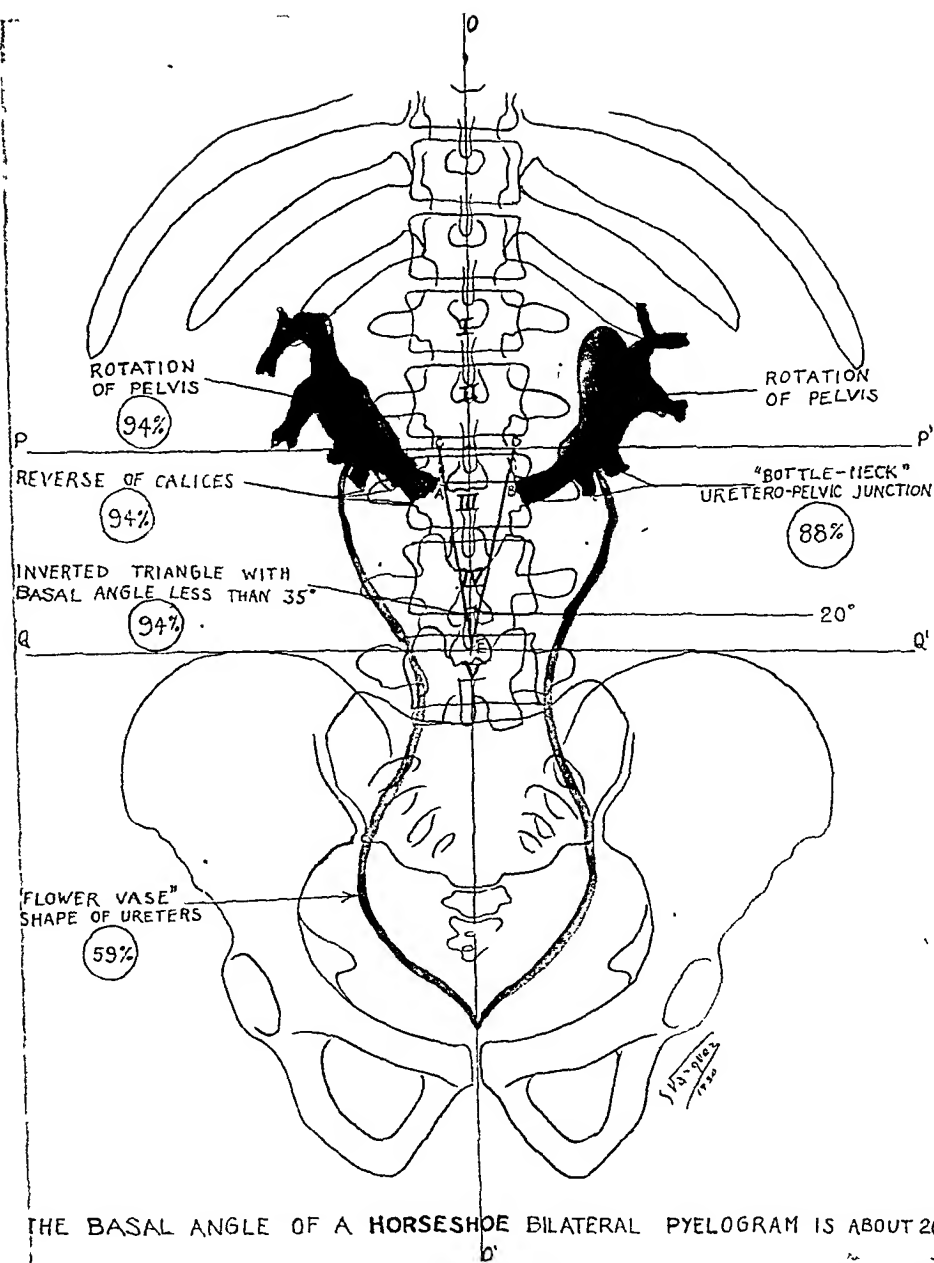


FIG. 39. Drawing of a bilateral pyeloureterogram from a typical symmetric type of horseshoe kidney on which are noted the most important points in diagnosis, which have been observed in this series of horseshoe kidney cases.

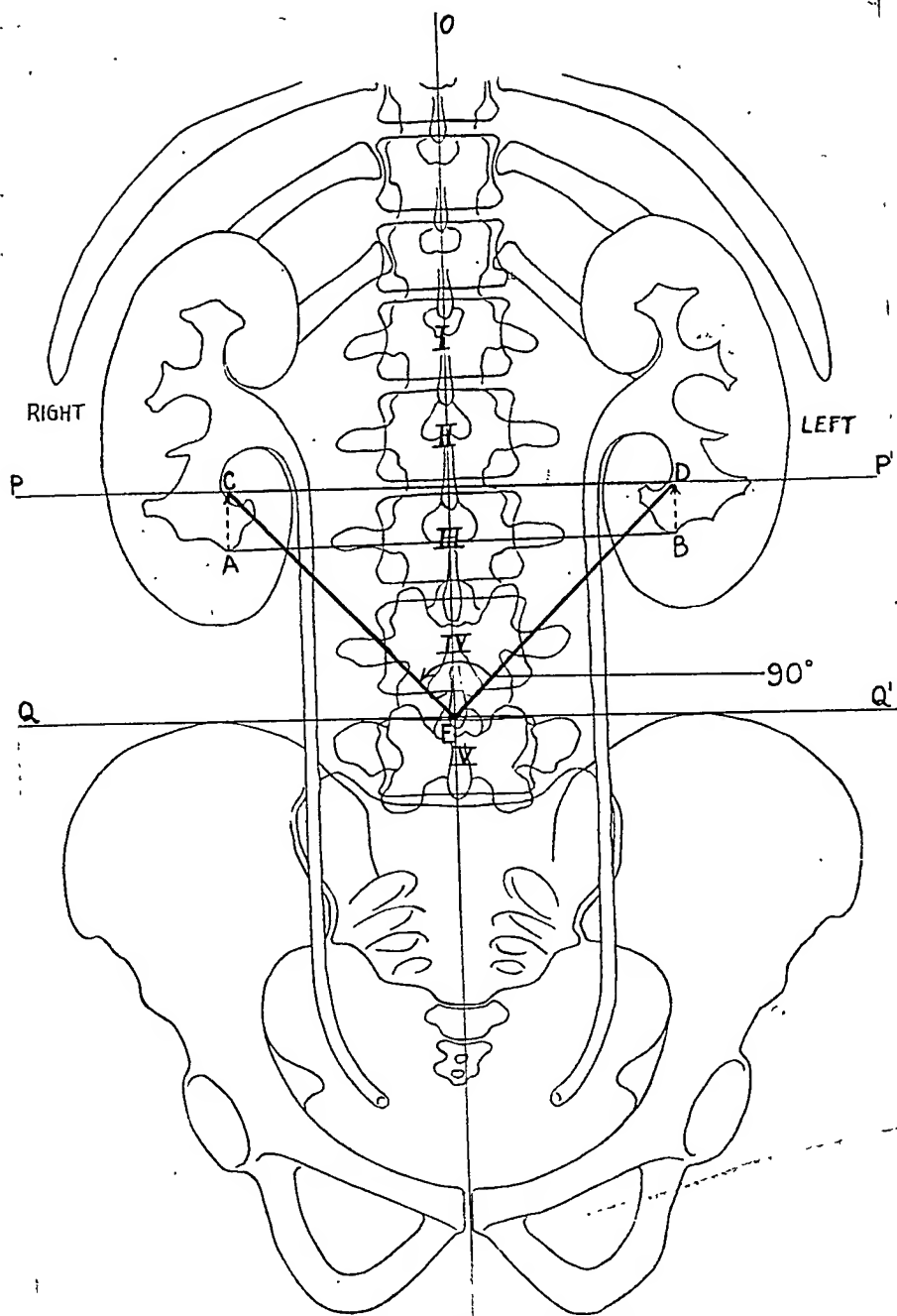
This drawing also serves to illustrate graphically the author's conception of the *horseshoe kidney pyelographic triangle* with its *minimum basal angle*, which is of special pathognomonic value in the diagnosis of this condition, as presented and described herein by the author (see text and Figs. 40 and 41).

Mention must also be made of a very graphic and suggestive radiographic sign that appears to be of positive value when present, one that has been observed in some 12 instances in this series of cases or in 59 per cent of the total number examined radiourographically. This sign, which I have called the "flower vase" figure of the ureters, is observed in cases of symmetric type of horseshoe kidney when the two ureteral catheters are roentgenographed *in situ*, lying one on each side of the vertebral column.

These catheters, in their ascent from the ureteral orifices in the bladder toward the areas of the renal pelves, are first seen taking an outward direction toward the sacroiliac joints on their respective sides; they then curve inward to form the sides of a figure resembling the rounded contour of a vase. After following the outline of the bodies of the first sacral and fifth lumbar vertebrae they gradually open outward again in their ascent until, as they finally reach their respective pelves, their configuration suggests the wide flaring mouth of a vase or flower pot holding up a bouquet of flowers, which is in other words the horseshoe kidney (see Fig. 39). Another suggestive point for diagnosis is furnished when the opaque ureteral catheter *in situ* in a flat picture is so curled or turned that it points inward toward the vertebral column. Although all these radiographic data are of unquestionable value and assistance in the diagnosis, they must always be confirmed by a thorough pyelographic examination.

6. *Cystoscopy*: With any persistent urinary symptom a cystoscopic examination should always be performed, provided that no contraindication exists. Not only may invaluable data be obtained with regard to possible lesions present in the bladder but in addition this procedure forms the basis for obtaining further information through the catheterization of the ureters and the renal functional test.

In horseshoe kidney disease with or without superimposed pathology, a few striking and interesting features may be revealed to the eyes of an expert cystoscopist which furnish a hint of what may be found above in the kidney. The urinary bladder may be affected in two ways, externally or internally. For example an extravesical pressure at its dome or on its lateral walls, detected cystoscopically, may point to the possibility of an ectopic horseshoe



THE BASAL ANGLE OF A NORMAL BILATERAL PYELOGRAM IS ABOUT 90°

FIG. 40. Diagrammatic drawing from a normal bilateral pyelogram representing the description of a normal *pyelographic triangle C-E-D* with a basal angle at E measuring 90°, which has been the average found in the measurement of 100 bilateral pyelograms in normally placed kidneys.

renal mass such as was observed in Case XII of this series. Internally, the direct observation of the bladder is of unquestionable clinical significance since it may reveal other congenital or associated pathological lesions. As a rule in this series of cases the bladder mucosa was found to be red and congested, suffering with a certain degree of cystitis. In only 7 cases (28 per cent) was it apparently normal. Extensively congested mucosa with cellules and trabeculations was observed in 6 cases (31 per cent). Other important cystoscopic findings were: hypertrophy of trigone and interureteric ridge in 3 cases, 2 small diverticula in 1 case, stone in the bladder in 1 case, 3 ureteral orifices in 1 case (see Case VIII).

Generally speaking, one may say that in the horseshoe syndrome, with the associated pathology that may be present, the cystoscopic picture is mainly that of urinary stasis with the bladder contracted, chronically inflamed, infected and extremely sensitive, owing to the over-irritation produced by the horseshoe kidney.

7. *Catheterization of the Ureters:* Ureteral catheterization is essential because of its value in the performance of a differential renal functional test, which is obviously needed in determining the practicability of heminephrectomy. Together with the urographic examination, it constitutes the most valuable adjunct for the establishment of a differential diagnosis. In horseshoe kidney or any other anomaly with marked dystopia, the catheter may pass only halfway into the ureter and meet an obstruction due to the low position that the organ may occupy in the bony pelvis, with consequent shortening of the ureter (see Fig. 26). But oftentimes the entire length of the catheter can be inserted without difficulty and may be seen in a roentgenographic plate deviated from the spinal column, or curled inward within the kidney pelvis. When combined with the x-ray the ureteral catheter *in situ* is of diagnostic value for ruling out doubtful shadows indicative of stone in the isthmus or inferior calices of the horseshoe renal mass or elsewhere in the upper urinary tract. It is of great assistance also in the preoperative treatment of the horseshoe kidney disease, when the latter is acute or is attended with urinary stasis, as is readily seen in the management of several cases here reported, and especially in Case 1.

8. *Renal Functional Test:* Estimation of the renal function has been of assistance in the diagnosis and, as has already been said,

it is of course of great importance in the prognosis, especially when surgical intervention, such as heminephrectomy, is to be carried out in cases of fused kidney. In the group of 19 cases diagnosed preoperatively and described herein, with complete urological examination, the functional test revealed in general a diminished urea excretion and phenolsulphonephthalein elimination, more marked on the side where a gross concomitant pathological lesion was definitely established. It is beyond question that the stage of function is parallel with the amount of renal damage inflicted, so that when one half is suffering for example with pyohydronephrosis or other pathological conditions that may incapacitate the organ, the function in that half may be zero, while that of the other half may be sufficient for the maintenance of life. Hence it can be concluded that the two halves of the organ, although they are connected by an isthmus of true renal parenchyma and constitute a single renal mass, still work independently of each other, and each half of the renal substance has adequate function to sustain life. It must be assumed that the horseshoe renal function will vary and will as a rule be diminished and compromised, in view of the etiological and anatomical factors and the chronicity of a disease of long standing, which has produced not only histological changes in the renal substance but also an intensification and continuous exacerbation of symptoms, expressed in pyelonephritis, urinary stagnation and renal damage. The overstimulation of the renal plexus and of the sympathetic and parasympathetic nerves by the traumatic insult of the isthmus may serve to explain the paranephritis and the chronic stage of interstitial nephritis, which play a potential rôle in diminishing the renal counterbalance of dye excretion and total elimination and thus create a strong tendency to develop further associated pathology with markedly diminished renal function, which will of course finally eventuate in a surgical kidney.

9. *Urography*: Because of the tremendous progress made in urological diagnosis in the last few years, we need to discuss in an intensive way the methods of examination upon which the horseshoe kidney diagnosis must in reality be based in the great majority of cases. Urography, which has made possible the delineation and visualization of the entire urinary tract, must be considered at this time from two different angles: (a) instrumental pyelography and

(b) intravenous pyelography, either of which will serve to establish a definite diagnosis.

(a) Instrumental pyelography, obtained by the injection of a radio-opaque medium through the ureters, is the most complete and accurate examination of modern urologic diagnosis. This routine method, which together with roentgenography has been employed in our series of cases, has enabled us to establish in advance the horseshoe kidney diagnosis in the 19 cases herein reported.

The most important points in the pyelographic findings or in the reading of a pyelogram have been discussed in the literature by various writers of modern days. In our own series of cases the most valuable pyelographic data obtained for the diagnosis of fused kidney have been, in order of frequency, as follows: (1) Inversion and rotation of the pelvis (approximately 90°), found in 18 of the 19 cases of this series, or 94.7 per cent. (2) Inversion of the calices, particularly the lower ones, which are seen lying centrally between the ureters and pointing toward the midline. (3) Unusual localization of the elongated and bizarrely shaped pelvis, which are as a rule quite close to the midline, frequently overlapping the vertebral column. (4) Peculiar position of the ureters. Due to the high implantation of these organs there is evident interference with the normal drainage of the lower calices, which are generally dilated, so that although the ureters appear to come from behind they are in reality cephalically or ventrally situated, giving the impression of a "bottle neck" where the ureter emerges from between two calices, instead of laterally and internally to the pelvis, as in a normal pyelogram. This position has been observed in 16 of our 19 cases, or 84 per cent (see Fig. 39).

By combining these various pyelographic data we may recognize a geometric relationship which I have chosen to call the *typical horseshoe kidney pyelographic triangle*, with a *minimum lower angle*, which has distinct diagnostic value, since it has been observed and confirmed in 18 of the 19 cases of this series diagnosed in vivo, or in 95 per cent. This triangle and its pathognomonic significance will be described in full further on. Other anomalies, such as duplication of ureters and reduplication of pelvis, have also been observed, in the course of taking the routine ureterograms, as for example in

Case VIII where 4 pelves and 4 incomplete ureters were detected (see Figs. 30 to 32).

We must however bear in mind from our embryological studies the important fact of the migration which the kidney normally undergoes in its ascent, and therefore, the considerable possibility that exists of observing the incomplete ascent of the organ to its lumbar position in the adult, or the incomplete rotation of the pelves, which may mislead in the pyelographic diagnosis (see Figs. 51-52). In our experience one pelvis may show an inward rotation, while the opposite pelvis is normally placed and when the outline of this kidney in a bilateral pyelogram reveals its normal integrity without renal fusion. This conception of urographic data applies, of course, to both the ascending and the descending method of urographic examination.

In the symmetric type of renal fusion as well as in those cases where greater concomitant pathology is present, it is obvious that the pyelographic findings will by their still more bizarre and amazing revelations serve to bring out the true pathological condition.

(b) Intravenous pyelography with the injection of uroselectan, which has been introduced very recently by Von Lichtenberg and Swick, is a new and valuable addition to our diagnostic methods of examination. It will serve in the near future to disclose much more frequently these types of lesions of horseshoe kidney disease, as its use becomes more widespread, and as the general practitioner as well as the roentgenologist learns how to interpret the urographic findings. In this series the new drug has been tried in one case (see Case III, Figs. 34 and 35). The diagnosis was first made in this case by retrograde or instrumental pyelography, but two weeks later intravenous urography with the injection of uroselectan was also done and proved to be of real value in the diagnosis of renal anomalies. Although the pictures obtained with the intravenous injection of uroselectan are not so clear as those taken with the retrograde pyelogram, uroselectan is nevertheless excreted with enough concentration to cast the shadow of the entire excretory urinary apparatus, which makes its visualization and diagnosis possible. Hence it seems to me that this new method which appears so simple and harmless is destined to become quite popular, because of its positive value under proper indications, particularly when cystoscopy and

catheterization of the ureters cannot be accomplished, and also in those cases in which patients fear cystoscopic instrumentation.

In the evaluation of the urographic data, I have tried to bring out all the most important points that will be of value in the diagnosis of this condition, using either the descending or the ascending urographic method of examination for obtaining pyelograms.

10. *The Horseshoe Kidney Pyelographic Triangle:* Finally, to the criteria already established I would now add one new sign, which has not been recorded before in the literature and which I have found to be of distinct pathognomonic value in the diagnosis of horseshoe kidney. This triangle, which I have illustrated in Fig. 39, arises from rotation of the kidney pelves and the inward inversion of the lower calices, and is due mainly, on the one hand, to the close proximity of the respective halves of the organ to the midline, and, on the other hand, to the unique position of the isthmus extending across the vertebral column. The narrow basal angle of this inverted triangle of the horseshoe kidney is in general less than 20° . It is therefore of great diagnostic value and can easily be drawn from a bilateral pyelogram or from a uroselectan intravenous pyelogram, being traced by the following rules:

1. Draw $O-O'$ along the vertebral column.
2. Draw $Q-Q'$ along the transverse bisiliac line.
3. The point E where $O-O'$ intersects $Q-Q'$ will be the apex of our triangle.
4. Draw $P-P'$ transversely between the second and third lumbar vertebrae.
5. The base of our triangle will then lie somewhere along $P-P'$.
6. Draw a horizontal line $A-B$ connecting the two lowest and most internally situated calices.
7. Project $A-B$ on $P-P'$ by drawing $A-C$ and $B-D$ parallel to $O-O'$.
8. $C-D$ will then be the base of our pyelographic triangle.
9. Since E is already the apex, draw $C-E$ and $E-D$, to form our triangle CED .

10. Measure the angle CED at E . *This is our angle of reference.*

The angle CED , which is the basal angle of our inverted triangle, is approximately 90° in normal kidneys while in horseshoe kidneys it averages approximately 20° .

The purpose of fixing the inverted triangle between P-P' and Q-Q' is the convenience afforded by its projection into a given place, so that the triangle will always be in the same position, no matter what the degree of dystopia of the organ.

This triangle with a minimum lower angle the writer believes to be of true pathognomonic value, when used as an adjunct to confirm the diagnosis of horseshoe kidney.

For purposes of accurate comparison I have taken careful measurements in 100 bilateral pyelograms from various types of renal pathology in which the kidneys were normally placed. As a result I have found that when the kidneys lie normally within their respective lumbar fossae, without fusion, the basal angle CED, as in the drawing of Fig. 40, made from the lowermost calices to the point E, has an average value of 90° , varying from a maximum of 103° to a minimum of 64° . In striking contrast to these figures are the findings in our series of horseshoe kidneys, in which the average value of this basal angle has been only 20° , with a range between a maximum of 36° and a minimum of 7° , as in Case XI. These findings are resumed in the following table (Table VI).

TABLE VI
VALUE OF BASAL ANGLE OF THE PYELOGRAPHIC TRIANGLE IN 119 CASES OF RENAL PATHOLOGY

	Kidneys normally placed	Horseshoe kidney
Average	90°	20°
Maximum	103°	36°
Minimum.	64°	7°

I submit, therefore, that this pyelographic triangle constitutes an interesting and practical observation which has not been recorded before, and which is of decisive value in the diagnosis of horseshoe kidney disease.

(To be Concluded)

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

EDITORIALS

INOPERABLE MALIGNANT TUMORS

IT is a certainty that at some future time science will have conquered that dreaded disease: cancer. One day its mysteries will be revealed and no longer will it be the problem it is today.

In the laboratory, among research workers, great strides have been made. Unceasing efforts among biophysicists, biochemists and pathologists have brought much valuable information to light. Trained clinicians throughout the world have added their inestimable part to the sum total. We must continue to work at this problem from every conceivable angle. The slightest bit of new information can be the means of striking the richer vein which will lead us to the final solution.

We feel that Willy Meyer's article in

this number of the Journal is important. It is important because Doctor Meyer has a large experience in dealing with patients suffering from cancer, his clinical work and observations covering fifty years.

What Doctor Meyer has to say concerning the acidosis treatment of patients afflicted with inoperable malignant tumors appears to raise justified hope for at least some of these unfortunates, although, of course, this new chapter of medical therapy is still in its very infancy. Until now the largest majority of these patients were universally considered doomed.

We hope the article will be read and re-read. It is another lead and deserves serious consideration.

T. S. W.

✓ CORRESPONDENCE ✓

To the Editor:

In the September, 1931, issue of THE AMERICAN JOURNAL OF SURGERY, in an article on "Gas Bacillus Infections in Civil Surgery," Dr. Leonard Orens states on page 458: "In a recent article by Kling, normal horse serum is advocated for gas bacillus infection. While we have no experience with this method and we do not wish to doubt its efficacy, we feel that the rationale of the method is not entirely clear. The advantages of adding normal horse serum to specific antitoxin appear problematical because the specific serum is, after all, horse serum and it seems more logical if larger doses are given that they be specific antitoxic serum."

The reason for employing this treatment and reporting the results are clearly stated in my article "The Treatment of Gas Gangrene with Normal Horse Serum," published in *Annals of Surgery*, February,

1930. To quote: "Antitoxic serum was not available in our city at this time." Further: "In case of war, the number of gas infections increases so rapidly that at some periods the production of specific antisera will lag behind. In such an emergency we feel that the substitution of horse serum is justified."

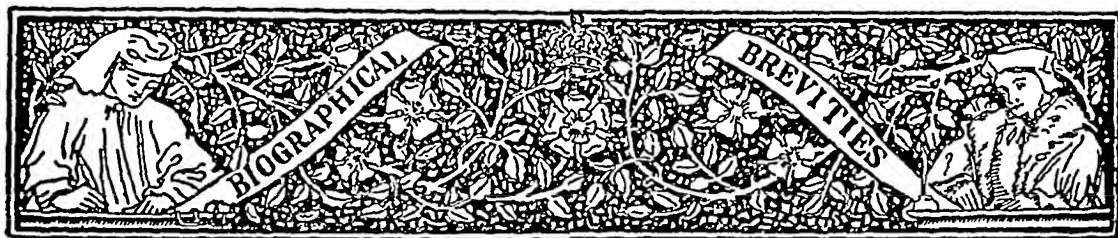
Moreover, I never suggested adding horse serum to specific antitoxin when the latter is available.

The rationale of the treatment was also pointed out. On the basis of experiments, we came to the conclusion that "the detoxicating effect is due to an unspecific destruction of toxin which is thermolabile and very sensitive to change of medium (pH concentration)."

I shall be very grateful if you will correct the misleading quotation of my work.

Very truly yours,
DAVID H. KLING, M.D.





AMERICAN PHYSICIANS BENJAMIN RUSH

BENJAMIN RUSH was born in Byberry Township, near Philadelphia, of Quaker parents, in 1745.

In 1760, at the age of fifteen years, he graduated at Princeton. He then served an apprenticeship of six years with a physician in Philadelphia, following which he went to Edinburgh. Two years later (1768) he took his M.D. degree. Followed a year in the hospitals of London and Paris.

At the age of twenty-four Rush began the practice of medicine in Philadelphia. He conducted the chemistry class at the Philadelphia Medical College. In 1789 he began his lectures on the theory and practice of physic. When the Medical College he had helped to found was absorbed by the University of Pennsylvania (1791) he was given the chair of the institutes of medicine and of clinical practice. In 1796 he succeeded to the professorship of the theory and practice of medicine.

Benjamin Rush's writings were many and varied. He wrote on many subjects outside of the realm of medicine. Professionally he is best known by the five volumes of "Medical Inquiries and Observations" which appeared at intervals from 1789 to 1798.

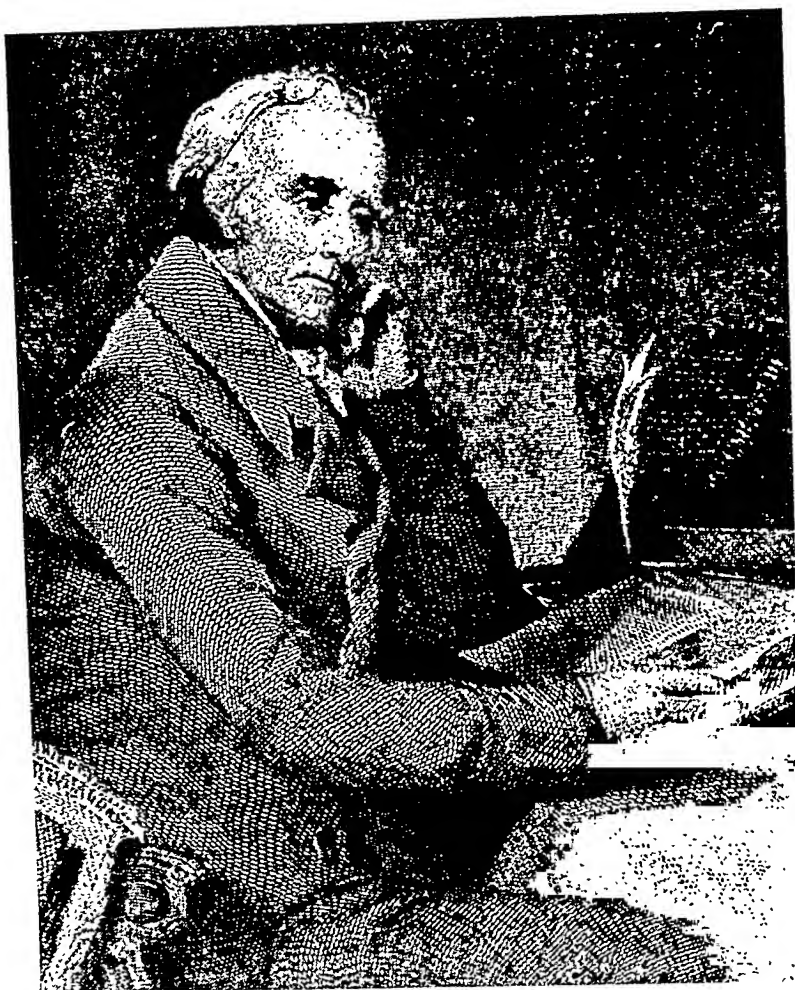
Rush was a friend of Franklin. He was a member of Congress from Pennsylvania in 1776. He was a signer of the Declaration of Independence. With James Pemberton he started the first antislavery society in America (1774). He was a member of the Pennsylvania convention which adopted the Federal constitution. We read of his splendid work when the yellow fever devastated Philadelphia (1793).

He had two sons—one, James (1786-1869), a physician.

Benjamin Rush contracted typhus fever and after a five days' illness died on the 19th of April, 1813.

T. S. W.





BENJAMIN RUSH

[[1745-1813]]



[From Fernelius' *Universa Medicina*, Geneva, 1679.]

BOOKSHELF BROWSING

JOHN WHITRIDGE WILLIAMS

[1866-1931]

HOWARD A. KELLY, M.D., F.A.C.S.

BALTIMORE, MD.

“**K**NOW ye not that there is a prince and a great man fallen this day in Israel?” Thus does a group of lifelong close friends, with many distinguished pupils, lament the passing of John Whitridge Williams, Chief of the Department of Obstetrics of the Johns Hopkins Hospital and Professor of Obstetrics in the Johns Hopkins University these thirty years and more.

Associated with Doctor Williams ever since he first joined my staff, immediately after graduating in medicine, I witnessed the growth of a man endued with those natural gifts of a true scientist—unquenchable zeal for knowledge and unremitting labors in the laboratory and in the practical field of applied obstetrics; I watched him give himself unsparingly to the major problems of his specialty, while working out a conspicuously beneficent life course and attracting to himself a coterie of outstanding men, some eleven of whom as his pupils have in turn become eminent leaders over a wide area of our country.

So, prematurely, has ended the rich career of one of our ablest and most inspiring contemporaries, called to leave his work October 21, 1931.

Born in Baltimore, January 26, 1866, he was the son of Doctor Philip C. and Mary Cushing Whitridge Williams. His father, who came from Winchester, Virginia, graduated in medicine from the University of Pennsylvania in 1850, studied in Paris, and practiced in Baltimore, was a man of high local reputation with a keen, logical mind, whom I first recall in the late eighties as reporting a case of extrauterine pregnancy which became intrauterine as it developed to a birth *per vias naturales*. He is also remembered for his “Review of the Trial of Mrs. Wharton for the Murder of General Ketchum” (1872); a reply to Doctor H. C. Wood’s “Review of the Medical Testimony for the Alleged Attempt to Poison Mr. Van Ness” (1873); “Hypodermic Injections of Ergot in Postpartum Hemorrhage” (1874); “Malarial Fever in Puerperal Women” (1883); “Ergot in

NOTE: I wish to express my deep appreciation of the interested cooperation of Dr. W. T. Howard, Jr., Dr. W. B. D. Penniman, Dr. Cary B. Gamble, Jr., and former associates.

Obstetrics" (1884). In 1867, he was president of the Medical Faculty of the District of Baltimore. Mrs. Williams was noted for accomplishment, beauty, and charm. Two other sons of this union are physicians: William Whitridge Williams of Denver and Dudley Williams of Baltimore.

A medical career was John Whitridge's royal right, handed down through his mother from a family practicing in America for more than 160 years and in Baltimore for over 110. In 1770, John's great-grandfather, Doctor William Whitridge, descendant of the William Whitridge who migrated from England to Massachusetts in 1635, established himself in Tiverton, Rhode Island, and became distinguished for chemical research at a time when scientists were rare; the old retorts of his private chemical laboratory still remain. He was a recipient of honorary degrees from Harvard and Yale. His wife was Mary Cushing, niece of Judge William Cushing of Scituate, Massachusetts, a member of the United States Supreme Court appointed by President Washington, and a descendant of Mathew Cushing, who had left his estates of Hardington and Hingham, England, because of ecclesiastical differences and come to Boston with his wife and children in 1638, later settling in Hingham, Massachusetts, named after his English home. Of their several sons, Joshua, graduate of Harvard, was a surgeon in the army during the War of 1812-14, lived and wrote near Charleston, South Carolina; two others, Thomas and John, came to Baltimore, the former to become a well-known merchant and man of large means and John to practice medicine. It was Mary Cushing Whitridge, daughter of the latter, who married our John's father. Doctor John Whitridge also had a son, William, and a nephew, Roland, who were physicians.

On the paternal side, the father and grandfather of Doctor "P. C.," as he was called, were lawyers of repute, of a distinguished colonial ancestry; both dropped dead before the age of sixty in the same

courthouse in Woodstock, Virginia. P. C.'s mother, Ann Maury Hite, was descended from Isaac Hite, Major in the Continental Army on the staff of General Muhlenberg, of whom a three quarter length portrait now hangs in the Williams' drawing room. The grandfather of Isaac, Baron Han Jost Hite, came from Alsace down the Rhine with his dependents and sailed from Holland for America where he led the German migration from Pennsylvania into the Valley of Virginia, took up his crown grant of forty thousand acres, and founded the present town of Strasburg; next to Lord Fairfax, he was the largest landowner in the State. A famous lawsuit between Fairfax and Hite arose later over their respective boundaries. Major Hite's first wife was the sister of President Madison; the second, Ann Tunstall Maury Hite, whose nephew was Commodore Maury, a great oceanographer, was descended from the Randolphs, Harrisons, Stiths, Dawsons, Ishams, Royals, Grymeses, Walkers, and Ludwells. The Ludwells in turn hark back to Philip, first Colonial Governor of the Carolinas, whose brother James was Colonial Secretary of Virginia. It was Philip Ludwell, Jr., who built the second statehouse at Jamestown and was the owner of the three houses next to it, the foundations of which are the only ones now clearly visible in the old settlement. His first wife was Hannah Harrison; one of their daughters married John Grymes (the Williams' ancestor) and another, a Lee, a relative of General Robert E. Lee. His second wife was Lady Berkley, widow of Sir William, Colonial Governor. Clayton Williams, a brother of Dr. P. C., was also a physician.

These family data and associated records were of such interest to our Doctor Williams that he preserved them with extreme care in a well-known tin box. Surely it is given to but few to boast of such an illustrious and unbroken professional and personal ancestry.

From youth John was diligent, systematic, and thorough, spending a large part



J. Whitridge Williams

of his holidays in study. After three preparatory years in the Baltimore City College, he entered the Johns Hopkins University where he became interested in chemistry under the inspiring leadership of Ira Remsen, graduating in 1866, the first and only person to take the A.B. in two years. Two years later, at twenty-two, he won his medical degree from the University of Maryland and went at once to Vienna and Berlin for general courses in bacteriology and pathology.

The following year, he joined the gynecological-obstetrical staff in the newly opened Johns Hopkins Hospital as a voluntary outside assistant, helping with the operations in the mornings and working up the operative material in the pathological laboratory in the afternoons; the foundation stones of his early reputation were laid in that quiet unassuming work. He was the youngest member ever admitted to the American Gynecological Society (1892), with a thesis on tuberculosis of the female generative organs, based on the autopsy room and the clinical material of the gynecological department. Many of his early publications were concerned with pelvic pathology: "Papillary Cystoma of the Ovary" in 1891 and "Deciduoma Malignum" in 1895, the latter from the Maryland General Hospital, given him by his valued long-time friend and, later, brother-in-law, Doctor William T. Howard, Jr.

He had obviously planned to devote himself to gynecology but embraced obstetrics as a sister specialty because of the unusual opportunity of developing this field on the inauguration of the Medical School. In 1894-95, he went abroad a second time, studying obstetrics in Leipzig, working up a fine monograph on sarcoma of the uterus in Chiari's laboratory in Prague, and visiting in Paris, whence he returned to become associate professor and teach obstetrics at the Hopkins until 1899 when the chair was divided: I retaining gynecology and Doctor Williams becoming professor of obstetrics in the University

and obstetrician-in-chief to the Hospital. It was ever Doctor Williams' strong conviction that the chairs naturally and properly should constitute a single department, an opinion frequently voiced, as in May, 1914, in an inaugural address as president of the American Gynecological Society, "I hope I may live to see the day when the term obstetrician will have disappeared and when all teachers, at least, will unite in fostering a broader gynecology, instead of being divided as at present into knife-loving gynecologists and equally narrow-minded obstetricians, who are frequently little more than trained man-midwives." It was also his conviction that women's clinics, as in continental Europe, should be established with large staffs for continuous investigation, making little use of the intern seeking only a smattering of a specialty.

While fully recognizing in his field the fundamental importance of bacteriology and pathology, and he was without question a foremost American contributor to obstetrical and gynecological pathology, he advocated other laboratory methods, especially physiology and chemistry. The early addition of a chemical laboratory promoted the study of the metabolism of the pregnant and lying-in woman. The metabolism during normal pregnancy was observed in order that the pathological deviations might be better understood. Important differences between the nutritional processes of the pregnant and the nonpregnant were noted, while constant and dependable metabolic peculiarities in the toxemias appeared neither in the blood nor urine.

The year 1911 brought the deanship of the Medical School with its additional heavy duties, which he resigned in 1923, having meanwhile become full-time professor of obstetrics in 1919, to give himself more fully to research and to the service of his elaborate attractive new Clinic.

His devotion to science never lessened his sympathy for the patient; indeed

every effort in the Clinic was directed toward the understanding of the processes of childbirth and the mitigation of the attendant pains and perils, associated with the lowering of the mortality incidence. A former resident testifies, "The scientific spirit permeated the staff and continues as a heritage to those who must carry on." It was the rule that no assistant could remain who was harsh or discourteous to the poor, free patients. He made the fees moderate that the service might be available to the larger number, recognizing also a limit to the value of professional services, irrespective of the individual.

With Doctor J. Hall Pleasants, under Mayor Preston, he rehabilitated, rather really rebuilt, Bay View, Baltimore's City Hospital, and established a full-time staff in pathology, medicine, and surgery, with representatives from Welch's laboratory as visiting and resident pathologists. Hopkins methods and organization permeated the new regime, and free access to clinics was accorded students from all medical schools. There are five or six hundred autopsies yearly.

Early in 1931, he took up the movement to repeal the Federal law forbidding the sending of birth control information through the mails.

It is one of life's misfortunes that men in the same institution often fail fully to appreciate the labors of their comrades, a shortcoming in part, I hope, due merely to lack of time. As I review Williams' scientific contributions in their entirety, I am astounded at the amount and regularity of his output and above all at the thoroughness with which he consistently handled his material. Never a year passed without the significant advancement of a great work. After the fashion of an earlier generation, he always furnishes a masterly historical resume in a manner calculated to captivate at once the reader's interest; with this retrospective *mis en scène*, he goes on to report his own work which is perfect in character and presentation.

I don't think we commented sufficiently upon it at the time, but at the age of twenty-four he plunged at once into exacting vicissitudes of authorship, as investigator and instructor thoroughly familiar with the cognate history of his field.

After a preliminary surgical paper in 1890, reporting attempts to fasten the retroflexed uterus to the abdominal wall without opening the abdomen, in 1891 there appeared four communications of high value: two on obstetrics and two on pathology, in as many different journals. His studies dealing at first with bacteriology and pathology were pursued in the laboratory of Doctor William Welch, whose influence was paramount during the formative period of his career. Later, after accumulating sufficient material, he began statistical studies continued without intermission to the end. Some seven conspicuous analyses of contracted pelves in their effect upon labor, from 1891 to 1926, were the more comprehensive because of the large number of colored in his wards. Studying particularly the pelvic outlet, he demonstrated the high importance of the funnel-shaped pelvis due to a narrowing of the diameter between the tubera as a common cause of dystocia. Always alert for anomalies, he secured material for monographs on spondylolisthesis (1899) and the rare deformities called after Robert and Naegele (1929). The investigation of the toxemias of pregnancy (begun in 1905, with Slemons in 1907), of perennial interest to him and his staff, added a great deal to our knowledge of their clinical course and treatment. Pathological monographs include elaborate investigation of chorio-epithelioma, hydatidiform mole, placental infarcts, syphilis, tuberculosis, and many other subjects; nowhere does the happy combination of pathologist and clinician show to better advantage than in his work on premature separation of the placenta. He found that the lesions, frequently not limited to the placental site, included hemorrhages

of variable size into the uterine musculature. The resultant impairment, modifying the contractions in labor and subsequently, was responsible for hemorrhage requiring hysterectomy. The etiology of these lesions he was inclined to attribute to an intoxication probably nephritic.

Since the days of Hugh Hodges, whose work was limited rather to the mechanism of parturition, no obstetrical leader in America has touched Williams in the sustained high character of scientific work in this field, not in any way to deprecate the splendid practical work of several of an antecedent generation and of others yet living. Without exception his writings are important authoritative documents of reference. He heeded well the injunction *ne sutor ultra crepidam* in writing some forty-six out of about one hundred papers primarily on obstetrical subjects, and this in spite of demonstrated unusual gifts in the field of gynecological pathology. He could scarcely help being aware of the fine caliber of his work, but I doubt if anyone ever heard him boast or lay claim to any particular excellence.

A coworker writes, "Wide reading, sound judgment in weighing evidence, straight thinking, and clearness of expression—all familiar qualities distinguishing him as a teacher—are conspicuous in his textbook, the best in English if not in any language. It is his crowning glory, in my opinion, and that view at one time at least was his own, for upon handing a copy of the first edition to Doctor Hurd, he remarked, 'Can you find room on your shelves for my *magnum opus*?' " First published in 1903, the "Textbook of Obstetrics," which has been a potent factor in promoting a better knowledge of obstetrics and still stands alone, passed through its sixth edition in 1930, with splendid new illustrations and many sections rewritten, such as chapters on anesthesia, technique of low cesarian section, toxemias of pregnancy, and blood transfusions. Less theory and more practice than in previous editions make it

valuable for practicing obstetricians. He is, as always, characteristically conservative. Reviewers note the physiology, anatomy, and pathology worked into the therapeutics, all presented in such clear-cut, understandable English.

Not only an indefatigable laboratory worker and practitioner, Doctor Williams in a remarkable way was the inspiring teacher, elucidating the fundamentals of obstetrics with a thoroughness unequalled in this country and always willing to teach what the balance of evidence indicated regardless of his personal views. The most improbable suggestions were never rejected; the constant injunction was, "Try it, if it be true, it's a great thing." He ever sought to impress upon his students that the purpose of their training was to train others in turn, and to this end he fostered their educational interests to the utmost. One of his former pupils, now professor of a basic medical science in a large university, while devoting much time to productive research of high order, absented himself from many classes and clinics. His extremely sketchy examination would have received a passing mark from Williams but for the unanimous protest of his staff. Appearing for re-examination the following fall, Doctor Williams made the test merely oral, with the query, "Did you spend a pleasant summer?" His wisdom, not clear to us at the time, was justified by the subsequent career of a genius with an international reputation in research.

A pupil testifies, "I have always been conscious of his interest in my welfare, although, characteristically, he never spoke of it. His friendliness became known through remarks to mutual acquaintances."

With students he was unusually popular. When the Wayman Adams portrait was to be presented to the University by his students, the fund was largely oversubscribed; any failure to respond to the appeal was invariably due to an incorrect address.

The walls of his lecture and consulting rooms are hung with the inspiring portraits of a large group of his antecedent collaborators.

In 1907, the University of Maryland and in 1912 the University of Dublin, Ireland, honored him with the sc.D.; the University of Pittsburg conferred the LL.D. in 1915.

As a distinguished colleague, he served as honorary president of the Glasgow Gynecological and Obstetrical Society in 1911-12; he presided over our oldest special society, the American Gynecological, in 1914-15, the American Association for the Study and Prevention of Infant Mortality in 1914-16, and the Medical and Chirurgical Faculty of Maryland in 1915-16. On the day of his funeral, almost at the very hour, one of the first Honorary Fellowships granted by the British College of Obstetricians and Gynecologists was conferred upon him.

Temperamentally and by heritage an aristocrat, he was ever courteous, considerate, and kindly in his professional and in all life's common relationships, although exhibiting a peculiar reserve and hauteur beyond the circle of his immediate family and intimates. A composite of mother and father, he had to a degree the outstanding traits of each. His fine mind attained its notable development and poise through the years of responsibility and painstaking labors.

Friends stress a knowledge of the Bible, reminiscent, doubtless, of the early home training exalting piety. Supporting the Episcopal Church as a formal member, he made the observation that "When the church openly declines to proclaim and preach a hell for unrepentant sinners, she loses nine-tenths of her strength." His father's deep religious convictions were reflected in his sense of personal responsibility and inclination to treat the faiths of others with a tender respect.

Little oddities of character are illustrated by the meticulous way in which each week checked off a gamut of seven pipes,

smoked alternately, and a sense of order prescribing that everything must always be found in its own proper place.

His friendship was ever ready for the test of sacrifice; as an intimate left for the war zone in France, he observed quite simply that there need be no worry about the family as he would care for them.

On January 14, 1891, he married Margaretta Stewart Brown, daughter of General Stewart Brown, who died February 21, 1929. Three daughters survive: Margaretta W. Wood (Mrs. F. Brayton), Mary Cushing W. Bridgman (Mrs. Eveleth W.), and Anne W. Niles (Mrs. Emory).

His second wife, Mrs. Caroline DeW. Theobald Pennington, a long valued laboratory assistant, was the daughter of Doctor Samuel Theobald of the Hopkins Faculty, granddaughter of Professor Nathan R. Smith, and great-granddaughter of Nathan Smith, organizer of the Yale, Dartmouth, Maine (Bowdoin), and Jefferson medical schools.

For some months past, Doctor Williams felt an unwonted lassitude, especially at his summer residence at Watch Hill, Rhode Island. While happy in his devotion to his children and grandchildren, to friends he seemed somewhat anxious, lacking the usual boyish enthusiasm often expressed in harmless practical jokes. Returning to Baltimore, with the best medical and surgical advice available, an exploratory upper abdominal operation was undertaken with negative results. Several days later, his life went out with tragic suddenness in a profuse hemorrhage from a large lower esophageal ulcer; the postmortem revealed small ulcers also in the stomach and duodenum, which had given no clinical evidence beyond a melaena.

A large circle of devoted friends, with colleagues at home and abroad mourn his loss; by none outside the immediate family will this be felt more poignantly than by those of the little group of intimates here in Baltimore, with whom he had maintained a touching lifelong intimacy.

BOOK REVIEWS

GYNECOLOGICAL ROENTGENOLOGY. A Roentgen Atlas of the Female Generative Organs with Special Reference to Uterosalphingography and an Outline of Gynecology in its Relations to Roentgenology, with Case Histories and a Chapter on Radium Therapy. *Annals of Roentgenology*, vol. XIII. By Julius Jarcho, M.D., F.A.C.S. 4to, 650 pp., 273 illus., 5 col. pl. N. Y., Paul B. Hoeber, Inc., 1931.

Doctor Jarcho has supplied a long needed want of roentgenologists, obstetricians and gynecologists. In the literature have appeared fragmentary articles touching on various points in this modern method of diagnosing and treating pelvic pathology, but this is the first worthwhile work which thoroughly covers the subject. In fact, it covers more than the mere indications and contraindications and technique of gynecological roentgenology. It considers many diseases peculiar to women and, in a way, covers the entire gynecological field.

We learn from the author that the "book originated as a monograph on uterosalphingography. By the natural accretion of related and relevant material, it gradually grew to include diagnostic measures involving pneumoperitoneum, as well as all other procedures, diagnostic and therapeutic, which necessitate the use of the roentgen rays or radium in obstetrics and gynecology."

The text is of agreeable sized type and the illustrations, which are abundant, are remarkable for their clarity and excellence of reproduction.

Doctor Jarcho may well be proud of his book. It is a work that may be said to be a necessity for every roentgenologist to possess. The obstetrician and gynecologist will profit by studying its pages. These days no one who pretends to these specialties can casually dismiss this subject. He must be thoroughly conversant with it. He meets with the necessity for it in his every day work, and he must either know the technic, himself, or know when the indications are present that the patient may be referred to a roentgenologist.

It will be a profitable investment for the roentgenologist, the obstetrician and the gynecologist to become thoroughly familiar with this work.

THE NURSE'S MEDICAL LEXICON, FOR THE USE OF GRADUATE AND STUDENT NURSES, OF PREMEDICAL AND DENTAL STUDENTS, AND OF THE GENERAL PUBLIC. By Thomas Lathrop Stedman, A.M., M.D., New York, William Wood & Co., 1931, 629 pp.

The first paragraph of the Editor's preface not only describes his intentions but also disarms possible criticism. It reads as follows:

In presenting this work to English speaking nurses the author hopes the members of that profession will agree with those among them whose advice he has sought that it will fill a want. His endeavor has been to include all terms definitions of which will be wanted by some of them at some time, while excluding all terms which would by no chance be wanted by any of them at any time. Being human, he has probably erred in one or other direction or in both, but his gratitude will be due those kindly critics and reviewers who will certainly point out any defects.

Only after considerable usage will defects, if any, become apparent. A rather careful examination has brought to light very few points for criticisms. It is a little irritating when looking up roentgen ray to be referred to x-ray and then find "see under ray." It would seem that the final reference could be referred to in each place. However, the Editor may have had a very good reason for this method. Frankly, this is the best small medical dictionary that the reviewer has seen and we do not hesitate to recommend it for the purposes for which it is intended.

DIE HARNORGANE IM RONTGENBILD (The Urinary Tract in Roentgenograms), By Prof. Dr. Eugene Joseph and Dr. S. Perlmann, Berlin. Ed. 2, enlarged and completely rewritten. With 33 text sketches, 3 col. pl., and 336 roentgenograms on 124 pl., 83 text pp. 124 pl. Main text in German, captions in German, English, French, and Spanish. Leipzig, Georg Thieme, 1931.

This beautifully illustrated volume embodies the ideal in a roentgenological atlas—numer-

ous, well-printed reproductions of good roentgenograms with an adequate yet not verbose description of the clinical aspects of the cases cited. The text includes details of technique of cystoureteropyelography by both retrograde and intravenous methods. Particular attention is paid to the technique for roentgenography of the bladder. The normal urinary tract is described in relation to the roentgen aspects; then the pathological kidney and ureter. The x-ray appearances of the bladder, both normal and pathological, the prostate, urethra and seminal vesicles all come in for full discussion. A final chapter discusses retrograde urography.

The work compares favorably with that of Young and Walters published by Hoeber, New York, although the latter contains much more detailed case reports and a much larger wealth of material illustrated.

ATLAS CHIRURGISCH-PATHOLOGISCHER RÖNTGENBILDER (A Roentgen Atlas of Surgical and Pathological Lesions). By Prof. Dr. Rudolf Grashey, Director, Roentgen and Light Institute, Univ. of Cologne. Ed. 3, enlarged and improved, 250 pp., 635 illus., 162 tables, and 184 text diagrams. Munich, J. F. Lehmann's, 1931.

Some such work as this is absolutely necessary in the hands of every physician who attempts radiological interpretation. The illustrations are well chosen. Certain of the most intricate ones are illuminated by line drawings, and all of them have a brief but adequate description of the clinical aspect in the text facing the illustrations, in such a way that one has the least possible difficulty in finding the text relating to any case in which he may be interested. Of particular value is the double index: one classifying the illustrations according to the anatomical situation, and the other according to the diagnosis. It is

thus very easy to use the atlas as a reference book to explain some difficult case. One can scarcely praise too much the persistence of the author and the wealth of material which has been placed at his command in the production and publication of such a valuable reference work. The fact that it is written in German should not deter any radiologist from acquiring a copy.

RÖNTGENUNTERSUCHUNGEN AM INNEN-RELIEF DES VERDAUUNGSKANALS (Roentgen Investigation of the Internal Relief of the Alimentary Tract). A Work on Clinical Roentgen Diagnosis, especially of Inflammatory, Ulcerative, and Malignant Lesions. By Prof. Dr. Hans Heinrich Berg, Dortmund. Ed. 2, rev., 250 pp., 247 illus. Leipzig, Georg Thieme, 1931.

Not all of our colleagues are aware that an entirely new phase of gastro-intestinal x-ray diagnosis has been developed within recent years by bringing out into relief the mucosa of the alimentary tract. Yet this is not altogether a new idea, but insistence upon it is new, it having been developed during the last three or four years, particularly in Europe. A special session of the recent International Radiological Congress in Paris was devoted to these mucosal studies. It is interesting to note that much more attention is being given to gastritis than we have formerly been accustomed to attribute to this subject. Chronic gastritis, ulcers and tumors are the topics given special prominence in the study of the stomach. Duodenitis and jejunitis also come in for a share of the discussion. Special technic is required for these mucosal studies and special apparatus must be provided. This new phase of gastrointestinal x-ray diagnosis is becoming more and more important, and no physician interested in radiological diagnostics can afford to be without this knowledge.



BOOKS RECEIVED

All books received in THE AMERICAN JOURNAL OF SURGERY are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgment. Books that the Editor considers of special interest to our readers will be reviewed in a later issue.

APPROVED LABORATORY TECHNIC. By John A. Kolmer and Boerner, Fred V. N. Y., D. Appleton & Co., 1931.

ARBEITEN AUS DEM NEUROLOGISCHEN INSTITUTE. By Heinrich Obersteiner and Otto Marburg. Band 11, Heft 11. Leipzig, Franz Deuticke, 1931.

PERIPHERAL NERVE INJURIES

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AND

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FIRST INSTALLMENT

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PERIPHERAL NERVE INJURIES

CHAPTER I

THE INCIDENCE OF PERIPHERAL NERVE INJURIES

INJURIES to peripheral nerves in civil life are sufficiently infrequent so that no one individual has been able to gather enough personal material to make a profitable clinical investigation. Our knowledge of peripheral nerves has come from the large number of nerve injuries which occurred during the Civil War, the Russo-Japanese War and the World War.

The incidence of peripheral nerve lesions is estimated by different authors in variable numbers and there is a wide divergence of opinion dependent upon a number of factors, one of which is the small amount of material under observation by the majority of individual investigators. Another factor is due to the exigencies of war which influence the character and accuracy of the observations made in a field dressing station or base hospital.

In the Russo-Japanese War statistics upon the frequency of peripheral nerve injuries varied from 0.75 to 3.4 per cent of the total number of disabled. In the World War the French observers stated that 18 per cent of injuries to the extremities showed injuries to the peripheral nerves. In the American material found in base hospitals, 14 to 16 per cent of all injuries to extremities showed injuries to the peripheral nerves, and it was estimated that 4.5 per cent of the total number of casualties showed injuries to the peripheral nerves. Lehmann, investigating the material of the German Army, concluded that from 1.5 to 2 per cent of all casualties showed lesions of the peripheral nerves. At one time 333 cases of injuries to the peripheral nerves were found in a personal bed-to-bed canvass of 5050 patients in certain base hospitals in France. Of these 2130 had wounds in the extremities.

Statistics relating to the incidence of peripheral nerve lesions have only a relative value, dependent as they are upon the intensity with which search for such lesions has been made in the various hospital centers. Statistics relative to the specific nerves are dependent upon a number of factors, which include the terminology employed. The failure to use the standard anatomical terminology and the fact that some nerve lesions escape notice because of the absence of prominent clinical signs, for example in tibial nerve injuries, are responsible for inaccurate calculations.

TABLE I

Ulnar.....	136
Median.....	93
Ulnar and median.....	58
Radial.....	165
Radial and median.....	12
Radial and ulnar.....	13
Musculocutaneous.....	4
Ulnar, median and musculocutaneous.....	3
Ulnar, median and radial.....	6
Axillary.....	7
Brachial plexus.....	71
Sciatic.....	160
Sciatic and small sciatic.....	9
Sciatic, peroneal branch.....	11
Sciatic, tibial branch.....	2
Peroneal.....	120
Tibial.....	25
Posterior tibial.....	12
Anterior tibial.....	16
Lumbar plexus.....	4
Femoral.....	19
External saphenous.....	16
Musculocutaneous.....	8
Internal saphenous.....	1
External cutaneous.....	3
Minor nerves.....	11
Total.....	985

Of equally great importance is the period of time following the injury when the tabulation is made. Many injuries have a tendency to recover spontaneously and rapidly. Notable

among such cases are brachial plexus injuries. Twice the number of these lesions found in general hospitals in the United States were found among a similar number of cases at base hospitals in France. Of a similar character are lesions of the tibial, posterior tibial, femoral and axillary nerves.

Of 1020 cases of injuries of the peripheral nerves 985 records suitable for study showed the most frequent injuries to have occurred in the following nerves in the order in which they are named: radial, 165; sciatic, 160; ulnar, 136; peroneal, 120; median, 93; brachial plexus, 71; combined ulnar and median, 58. (Table I.)

Purves Stewart noted 61 cases of brachial plexus lesions in material comprising 316 cases. In the collection of Lehmann, injuries to the radial nerve exceeded by far those to the ulnar. Foerster observed 3963 peripheral nerve injuries during the Great War. Of this large group 3907 were due to a gunshot wound. Table II is taken from Foerster's statistics:

TABLE II
INCIDENCE OF PERIPHERAL NERVE INJURIES (FOERSTER)

Radial..	936
Median.	800
Ulnar.	742
Sciatic...	523
Peroneal.	183
Tibial..	112
Axillary.	82
Musculocutaneous...	71

It is interesting to note that in this large group injuries of the three major nerves in the upper extremities are far more frequent than those of the lower extremity. Here again evidence is presented of the fact that the radial is the most frequently injured peripheral nerve. When injured simultaneously, combined injuries of the median and ulnar nerves were the most common and median-radial, median-musculocutaneous next in frequency. It was seldom that the radial and ulnar nerves were injured in a combined lesion.

The statistics of Burrow and Carter based upon 1000 cases showed 327 ulnar, 242 median, 204 radial and 121 sciatic nerve lesions. Limouzi's study of 139 cases agrees in the main with this incidence except that the radial nerve was injured more frequently than the median. Jalcowitz has recorded 293 cases in which the radial nerve was injured twice as frequently as the median. He, too, found a high percentage of brachial plexus injuries. Because of the many factors which make them so variable and inaccurate these statistics are of general interest only. When it is realized, however, that they represent material obtained from war experiences it may be seen that such a collection of cases would be impossible to duplicate in the practice of civil life. It may be emphasized, therefore, that the conditions under which studies were carried out upon this material were far from ideal and that in the future every attempt should be made to facilitate attempts to obtain the maximum information from such material.

CHAPTER II

EXAMINATION

I. HISTORY

The history of the patient should include the date of the injury, the nature of the agent which produced it and, if they are present, an accurate localization of the wounds of entrance and exit. The position of the patient when he was wounded is of importance and may explain the localization of an injury to a nerve which on first inspection may not seem to be included within the course of the projectile. The character of the sensation felt upon being wounded may be described by the patient as stabbing or electric-like. The presence of pain or numbness and the radiation of this pain or the extent of the numbness should be recorded. The occurrence of any trauma not due to the wound itself, such as a contusion due to a fall, should be noted. The onset of the paralysis should be carefully ascertained as to whether it occurred immediately after the injury or some time later. It should be stated whether or not a tourniquet was applied and what the nature of the original dressing was. Discoloration and swelling should be described. Secondary hemorrhages should be recorded and a careful inquiry should be made as to the presence of suppuration. The existence of fractures and the character of their management should be ascertained.

A detailed statement should be obtained as to the progress of the neurologic condition. This should include a description of the progress of the paralysis, as to whether it has receded, increased or remained stationary. The presence of subjective sensory disturbances such as pain, paresthesias or burning and the date of their appearance, their increase or diminution, their localization and their radiation should be inquired about. Objective sensory disturbances, such as anesthesia or hyperesthesia, which have been noted by the patient should be

described minutely. The evolution of trophic, vasomotor and secretory disturbances and the progress of muscular atrophy should be noted. The color of the skin, the temperature of the extremities, the character of the perspiration, the appearance of ulceration or sloughs, changes in the nails and hair all should be recorded.

Finally the specific treatment of the disability should be described. If an immediate operation was performed, its character should be determined, as to whether foreign bodies were removed, arteries ligated, or a nerve sutured, or freed. Although it was presumed during the Great War that such facts should appear on the Field Medical Card, at times such information was missing and occasionally patients were operated upon who had had primary sutures performed at the front.

II. GENERAL EXAMINATION

Frequently the appearance of the injured extremity with particular reference to the deformity present, such as a wrist drop or clawed fingers, will call the attention of the observer to the particular muscles which require investigation. A systematic and thorough examination is indispensable for a proper diagnosis. It is well to start with a careful scrutiny of the site of trauma. In cases of gunshot wound the exact course of the projectile should be noted and scars of entrance or exit, or operative scars resulting from the removal of foreign bodies, ligation, or débridement should be described. The appearance of the site of injury as well as the presence of induration or other changes in adjacent parts should be recorded. Details of particular examinations will be described later but it may be stated that the examination should include motion, sensation—both subjective and objective, vasomotor changes, reflexes and the reaction of the muscles and nerves to electrical stimulation.

CHAPTER III

EXAMINATION (*Continued*)

III. MOTION

One of the functions of a peripheral nerve is the transmission of motor impulses. When a peripheral nerve is injured or severed its function is diminished or destroyed. As a result, loss of motion ensues. If the loss of motion is complete, it is defined as a paralysis; if incomplete, as a paresis.

The state of the function of motion is determined by an examination of a muscle at the moment of voluntary or willed movement. Inasmuch as many muscles are deep-seated and others seem to contract when synergistic muscles are shortened, it is impossible in many instances to determine paralysis by an examination of the muscle itself. Consequently, the preservation of the function of muscles is largely determined by the examination of segments about the joints.

Loss of motion may be the result of conditions other than a paralysis of a muscle or muscles. Among these causes may be included local shock, pain, swelling, fractures, dislocations, adhesions, ankylosis of joints, contracture of opposing uninjured muscles, spasm, sclerosed fibrous tissue as in ischemic paralysis, section or loss of tendons and muscles and hysteria.

POSTURE: After a proper evaluation of the degree of pain and swelling present, an examination of the posture of the extremity should be made. Loss of function of any peripheral nerve produces a position and deformity which is characteristic, such as the *wrist drop* of radial nerve paralysis (Fig. 1). Frequently in advanced cases, there is such a marked protrusion of the metacarpal bones due to the relaxation of the ligaments of the wrist, that there is the appearance of a tumor of that joint. Other deformities include the talipes equinovarus or *foot drop* of peroneal nerve paralysis (Fig. 2); the characteristic *clawed fingers* of ulnar nerve paralysis (Fig. 3); the *ape*

band of an ulnar and median nerve paralysis (Fig. 4); the characteristic *position of the thumb* in a plane with the palm in median nerve paralysis (Fig. 5); the *sagging shoulder* of a



FIG. 1. Wrist drop deformity in radial nerve paralysis.

spinal accessory nerve paralysis and the *winged scapula* of a long thoracic nerve paralysis.

RANGE OF MOVEMENT: The degree of motility of segments about a joint should be determined by examination of both active and passive motion. In examining for passive motility due consideration must be given to the pain elicited. The range of movement may be determined by a goniometer and measured in degrees of a circle (Fig. 6), or by tracings obtained from moulds made with a flexible lead tape, first obtaining a tracing of the movements of the segment in one direction (flexion) then in the other direction (extension) (Fig. 7).

It is important to note the position of segments of joints adjacent to the ones being examined. For example, in a radial nerve paralysis with wrist drop there may be some interphalangeal joint fibrosis. If the range of flexion of the fingers is

obtained with the wrist "dropped" it will be far less than with the wrist in a position between extension and flexion (Fig. 8). Similarly in a median and ulnar nerve paralysis the range of

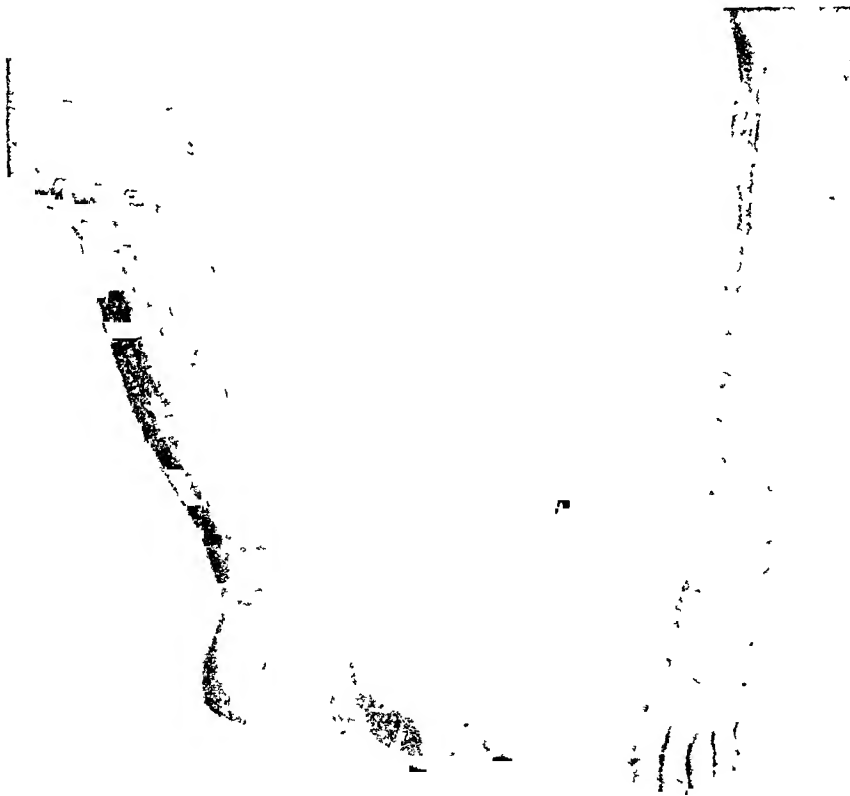


FIG. 2. Foot drop deformity in peroneal nerve paralysis.

extension of the fingers will be less with the wrist extended than when the wrist is flexed. In a peroneal nerve paralysis, the dorsal flexion of the foot will be less with the leg extended than when it is flexed.

ACTIVE MOTION: Because of the many factors which enter into the movement of segments about the joints, but particularly because of the frequency with which more than one muscle may produce similar movements about the segments of the joints, the necessity for great care in the analysis of all muscle movements must be stressed.

The segments about the joints in the body normally may be moved voluntarily in certain directions to certain degrees such as flexion, extension, abduction, adduction, rotation and



FIG. 3. Clawed hand deformity in ulnar nerve paralysis.

circumduction. The failure of such movements indicates a loss of function which, with certain *precautions*, may be attributed to the motor paralysis. Having eliminated such causes as pain, swelling, contracture, spasm, fibrosis, ankylosis of joints, fracture, etc., one may begin to study the loss of function by *observation* of the range of motility in various directions. Here certain precautions are necessary. Each joint must be studied separately. The part of the extremity proximal to the joint tested should be passively immobilized and the muscles moving the segment should be placed in a position which is neutral, so that their function can best be motivated. For

example, in a radial nerve paralysis, although the flexors of the fingers are uninjured, the degree and force of motility is diminished unless the hand is passively extended on the wrist.



FIG. 4. Ape hand deformity in a combined median-ulnar nerve paralysis.

The influence of gravity must be properly evaluated and its forces nullified by proper position. Paretic muscles may be capable of contraction but too enfeebled to move a part or whole of any extremity against gravity. For example, a deltoid muscle may be paretic to such a degree that abduction of the arm is impossible when the patient is standing, yet with the patient in a supine position, abduction of the arm may be possible. At times it is advisable to facilitate movement further and diminish the force of inertia by placing the paretic extremity on a board which has been powdered with talcum. In a

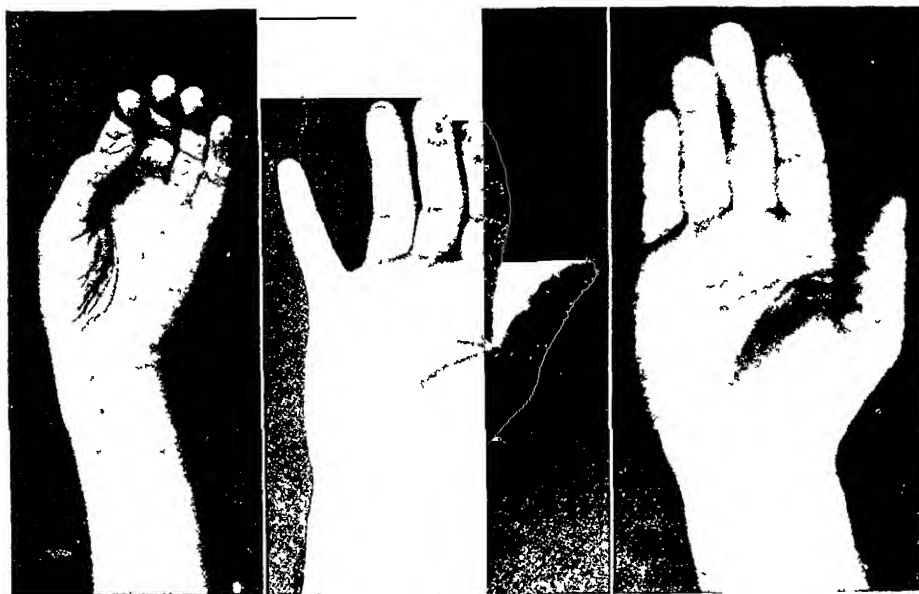


FIG. 5. Appearance of hand in a median nerve paralysis.



FIG. 6. Goniometer to measure range of motion of joints.

radial nerve lesion, extension at the wrist may be impossible with the forearm unsupported and in a pronated position, yet feeble extension may be produced with the forearm in a posi-

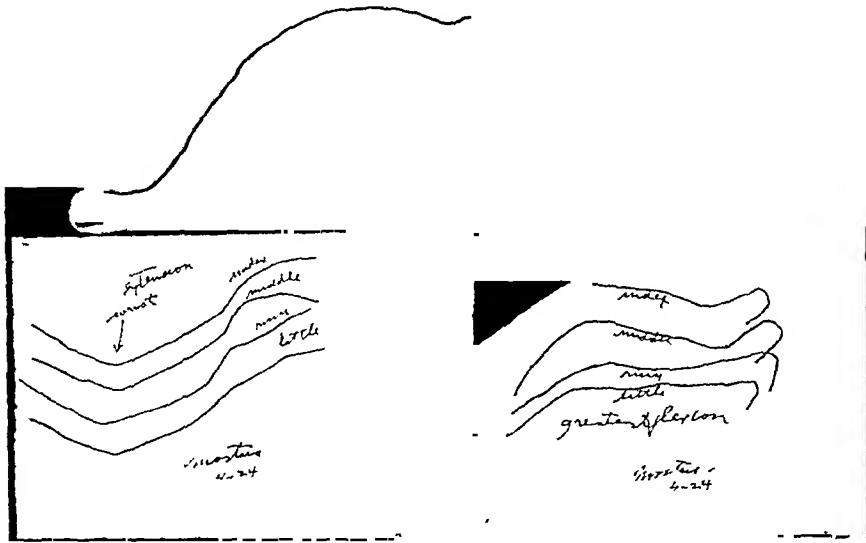


FIG. 7. Tracings of range of movement obtained with a flexible lead tape.

tion midway between pronation and supination and supported on a powdered board. Similarly, flexion of the forearm may be impossible against gravity, but possible if the upper extremity is supported in a position of abduction at a right angle. Extension of a paretic quadriceps femoris may be impossible in an erect position with the thigh flexed and quite possible when the lower extremity is supported on its inner or outer surface while the patient lies on his side. Such precautions must be taken as well in examining the hamstrings, the dorsal and plantar flexors of the feet; in short, of all the muscles of the body.

At times the force of gravity works in the opposite direction and, as will be pointed out under supplementary movements, it often produces a movement which is misinterpreted as muscle

function. For example, when the triceps is paralyzed, if the arm be abducted, the forearm flexed and then externally rotated, gravity may produce extension at the elbow. Similarly,



FIG. 8. Imperfect flexion of fingers in a radial nerve paralysis.

when the quadriceps femoris is paralyzed and the thigh passively flexed on the abdomen and the leg on the thigh while the patient is in a supine position, gravity may extend the leg.

At times a muscle may be so enfeebled that it cannot change the position of the segments about a joint, but its contraction can be ascertained by palpation. Frequently such examination leads to erroneous conclusions. For example, in

NAME	DATE	DATE	DATE	DATE
	M	FC	M	FC
Trapezius				
Rhomboids				
Levator anguli scapulae				
Serratus magnus				
Deltoid				
Infraspinatus & Teres minor				
Subscapularis				
Pectoralis major				
Latissimus dorsi				
Triceps				
Brachialis anticus				
Biceps				
Supinator longus				
Supinator brevis				
Pronator teres				
Extensor carpi radialis				
Extensor carpi ulnaris				
Extensor communis digitorum				
Extensor indicis				
Extensor minimi digitorum				
Flexor carpi ulnaris				
Flexor carpi radialis				
Flexor sublimis digitorum				
Flexor profundus digitorum				
Palmaris longus				
Interossei-lumbricales				
Hypothenar group				
Extensor longus pollicis				
Abductor longus pollicis				
Extensor brevis pollicis				
Flexor longus pollicis				
Opponens pollicis				
Adductor pollicis				
Gluteus maximus				
Gluteus medius				
Pyramidalis-gemelli obturators				
Ilio-psoas				
Tensor fascia latae				
Pectineus-adductors-gracilis				
Quadratus femoris				
Sartorius				
Biceps-semitendinosus				
Semimembraneosus				
Gastrocnemius-soleus				
Peroneus longus				
Tibialis anticus				
Extensor communis digitorum				
Extensor hallucis				
Tibialis posticus				
Extensor brevis digitorum				
Interossei-lumbricales				
Flexor longus digitorum				

MOTION (M) -- Paralyzed (P); Very weak (VW); Weak (W)

FARADIC CURRENT (FC) -- Normal (N); Weak (W); Absent (A)

Fig. 9. Chart to record strength of motor function.

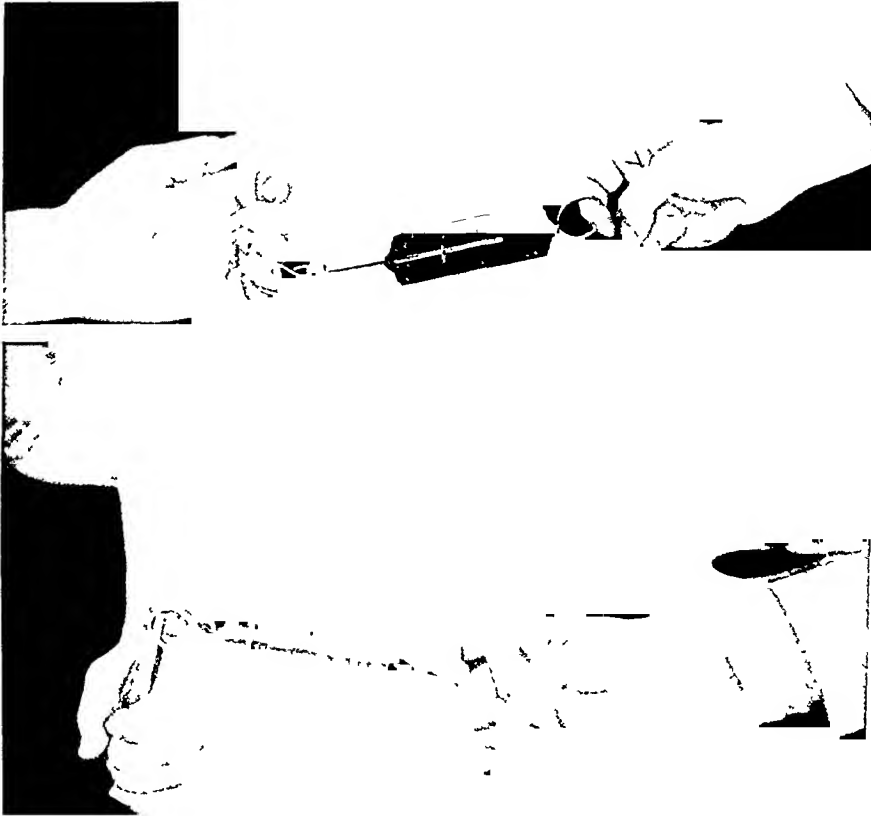


FIG. 10. Spring scale dynamometer.

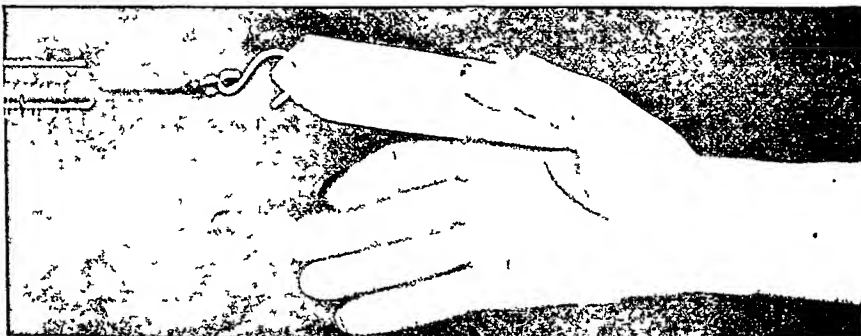


FIG. 11. Method of examining strength of pronation and supination.

ulnar nerve paralysis the tendon of the flexor carpi ulnaris may seem to contract when the wrist is flexed by the flexor carpi radialis and palmaris longus.

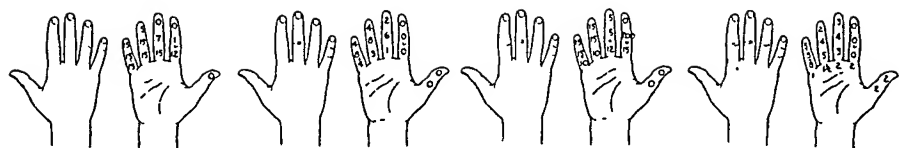
It may happen that if the segment be passively moved in the direction of the action of the paretic muscles they then may actively increase this movement. For example, in a peroneal nerve paresis, if the foot be passively dorsiflexed to a degree, the patient may then be able actively to increase the degree of dorsiflexion of the foot.

Frequently although the patient may not be able to produce a movement of a segment in a certain position he may be able to retain this position when it is passively produced. For example, in a paresis of the extensors of the wrist, when the wrist is passively extended, the patient may for a brief interval hold it in that position.

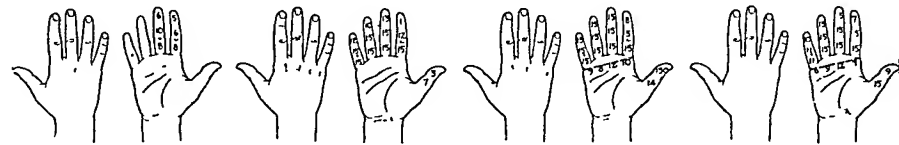
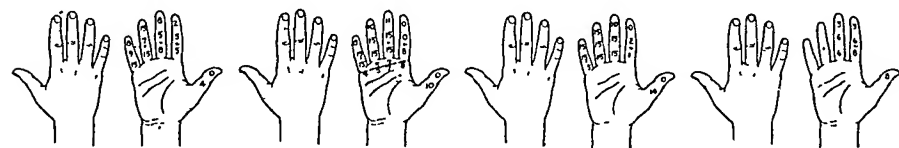
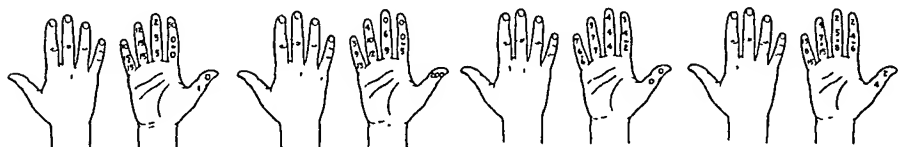
The degree of *motor deficiency* may be measured relatively by the observation of the degree of capability of producing changes in the position of the segment in (a) a neutral position, (b) against gravity and (c) against interposed resistance. In estimating the amount of interposed resistance one may compute it in degrees of one's own strength or as compared with the strength of the uninjured corresponding segment of the patient. For example, in a paresis of the extensors of the wrist, one may compare the strength of the paretic to the normal side by resisting with one's own hands the extension at the wrist. The degree of motor deficiency may then be described as paralyzed, very weak, moderately weak, weak, or moderately strong, and so recorded (Fig. 9).

The necessity for accuracy in the examination of motor function cannot be overemphasized. Careful measurements and precise records are necessary not only for the purpose of diagnosis and prognosis, but for the determination of the progress of a case. Accurate measurement of motor function is possible only by a dynamometric examination.

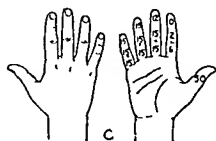
A simple and accurate method may be employed by the interposition of a spring scale between the examiner's hand and



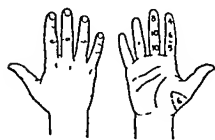
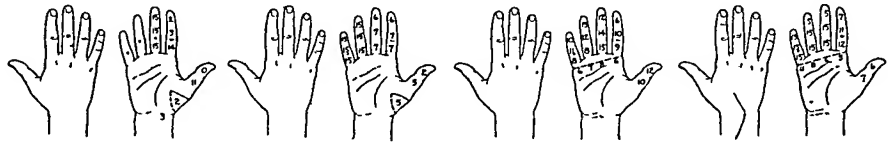
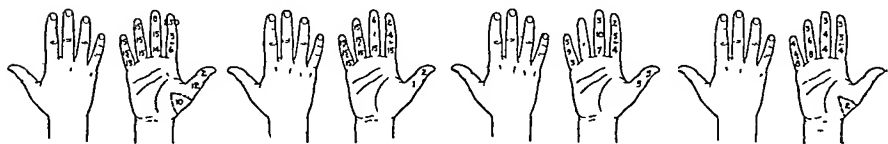
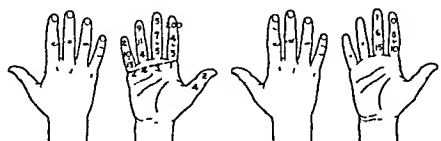
A



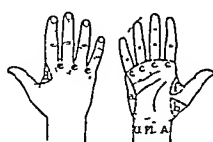
B



C



D



E

FIG. 12.
[196]

a segment to be examined (Fig. 10). One may employ several such scales, some measuring to 500 grams and others as high as 50 pounds. For example, if we wish to determine the strength of flexion of the distal phalanx of the thumb we fasten the hook of the scale to the distal phalanx and holding the scale in one hand, fix or immobilize the remaining portion of the thumb with the other hand. The patient is then requested to flex the thumb and the degree of motor function read in terms of grams or pounds. It is essential that influence of movement of adjacent segments be avoided by passive fixation.

When one is dealing with more complicated movements such as pronation or supination, rotation, etc., a flat piece of wood at one end of which a hole has been drilled may be employed. The hook of the scales is inserted into the hole and the patient grasps the flat piece of wood, and as he turns it either by pronation or supination, the results may be read upon the scales. At times it may be necessary to bind the hook of the scale or the piece of wood to a segment about the joint being examined (Fig. 11).

The results so obtained may be recorded opposite the name of the muscles supposed to move the segment in the direction measured, or, and this is far more useful and accurate, upon a diagrammatic representation of the segment. For example in examining the movements of the hand and fingers each result is noted upon the palmar or dorsal surface of the part of the hand recorded. Schematic representation of abduction of the finger, flexion of the proximal phalanges, adduction, opposi-

FIG. 12. Chart to record degree of motor power.

- A. Anatomical section of median nerve confirmed at operation with complete sensory loss.
- B. Severe lesions of median nerve, without anatomical section, confirmed at operation. Sensory loss incomplete.
- C. Severe but incomplete lesions of median nerve with marked sensory loss.
- D. Recovering or partial lesion of median nerve. Complete sensory loss in only one instance.
- E. Method of recording results of examination: positions indicated by various letters denote the following muscles; a, hypothenar muscles; b, opponens pollicis; c, lumbricales; d, first dorsal interosseous; e, remaining interossei; f, adductor pollicis; v, flexor carpi ulnaris; Pl, palmaris longus; A, flexor carpi radialis.

tion and short abduction of the thumb may be denoted as in the accompanying illustration (Fig. 12). In lesions of the ulnar and median nerve this type of examination and recording has



FIG. 13A.

FIG. 13. Supplementary movements in radial nerve paralysis.

led to the observation of many phenomena of great diagnostic and prognostic value which have not heretofore been described. These will be dealt with under injuries of the several nerves.

SUPPLEMENTARY MUSCLE MOVEMENT: Supplementary muscle movement, supplementary motility, or trick movement is frequently responsible for misinterpretations in the examination of cases of peripheral nerve lesions.



FIG. 13B.

The preservation of certain movements, the loss of which is supposed to follow particular nerve lesions, has been observed for many years. Sherren called attention to the fact that Swan, in 1834, was astonished at how much a rabbit could move its leg after experimental section of the sciatic nerve. Later, Létieuvant studied this phenomenon and termed it supple-

mentary motility. Since that time numerous investigators have observed its presence in peripheral nerve lesions (Duchenne, Beevor). We owe much of our present knowledge of these movements to these men. Sherren, Head, Claude and Athanassio-Bénisty are among the recent observers who have noted its presence. The American workers have been particularly interested in these movements and have contributed considerable information as to their occurrence (C. C. Coleman, A. H. Wood and L. J. Pollock).

These movements may be caused by a number of factors. Among these may be included the anastomotic supply of muscles from adjacent nerves and the not uncommon existence of an atypical nerve supply. For example, total supply of the flexor brevis pollicis may be by the ulnar nerve and the supply of the first dorsal interosseous by the median. Such movements may likewise be produced by muscles other than primary movers in such an action. For example, flexion of the wrist may be produced by contraction of the abductor longus pollicis and the extensor ossis metacarpi pollicis. They may also occur as the result of mechanical factors which produce a change of direction of leverage by shortening and lengthening of tendons and muscles passing over several joints. For example, in a lesion of the radial nerve with paralysis of the extensors of the wrist, when the wrist drop does not exceed an angle of 120 degrees, complete flexion of the fingers produces extension at the wrist (Fig. 13). Slight movement which results from the recoil of elastic tissue following a movement in a direction opposite to the one desired often occurs. For example, in median nerve paralysis flexion of the distal phalanx of the thumb may be imitated by the recoil which occurs following strong extension of the distal phalanx of the thumb. Supplementary movements may be the result of the force of gravity. For example, in paralysis of the median nerve, pronation may be produced first by stretching the long wrist and finger extensors and then, the forearm resting on the knee, the remaining movement of pronation is produced by allowing the

force of gravity to carry the forearm through the subsequent action.

Some of the conditions other than nerve injury which may



FIG. 14. Types of joint changes in peripheral nerve lesions.

produce defects in motion deserve additional description. Loss of motion following injuries of war may occur as the result of local *shock* and not as a result of direct injury to the peripheral nerve. Immediately following the reception of a gunshot wound there may be a complete paralysis of an extremity. This paralysis more or less rapidly disappears and may leave, if a peripheral nerve is injured, a paralysis of only the muscles supplied by that nerve. Return of motor function occurs in from a few hours to a number of days, depending upon the amount of shock and the degree of injury of the soft parts and blood vessels. This loss of motion is far more common in injuries which are the result of shrapnel and high explosive shells than

of machine gun bullets. It is a constant accompaniment of wounds complicated by fractures of long bones. It is not necessarily an accompaniment of loss of consciousness or



FIG. 15A.

FIG. 15. Shortening of opposing muscles in peripheral nerve lesions.

surgical shock. This loss of motion is rarely accompanied by loss of sensation and it is notable that even when a nerve is injured by local concussion or at times by contusion, frequently motor function is lost whereas sensation is preserved. S. Weir Mitchell called attention to this during the Civil War.

JOINT CHANGES: Weir Mitchell also called attention to the common affection of joints in lesions of the peripheral nerves and, as in the Civil War so in the late war, these changes produced immobility at times of greater importance than

paralysis of muscles themselves. These joint changes may be of a number of varieties and their causes may not be easily determined. Of the known causes there may be enumerated

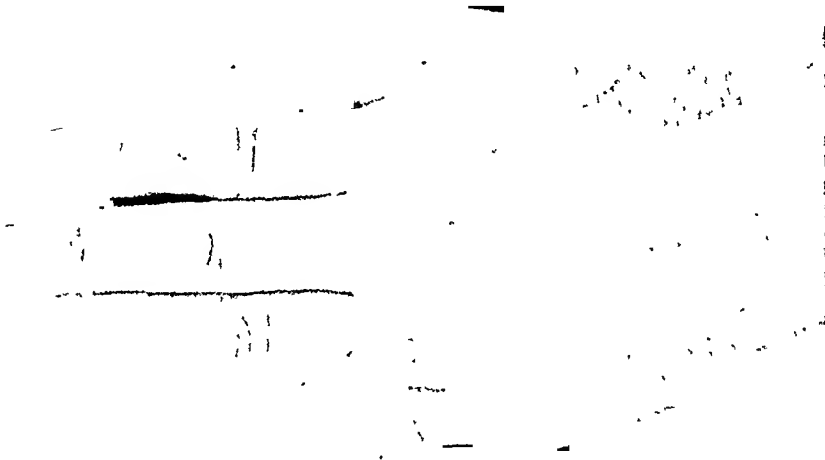


FIG. 15B.



FIG. 15C.

fractures in the joints, dislocations, suppuration of joints, prolonged suppuration of nearby parts, prolonged immobilization, ischemic contractures resulting in retraction of muscle tendons and certain nervous lesions, possibly of reflex sym-

pathetic nervous system origin, the character of which is unknown.

Although it is generally supposed that prolonged immobiliz-

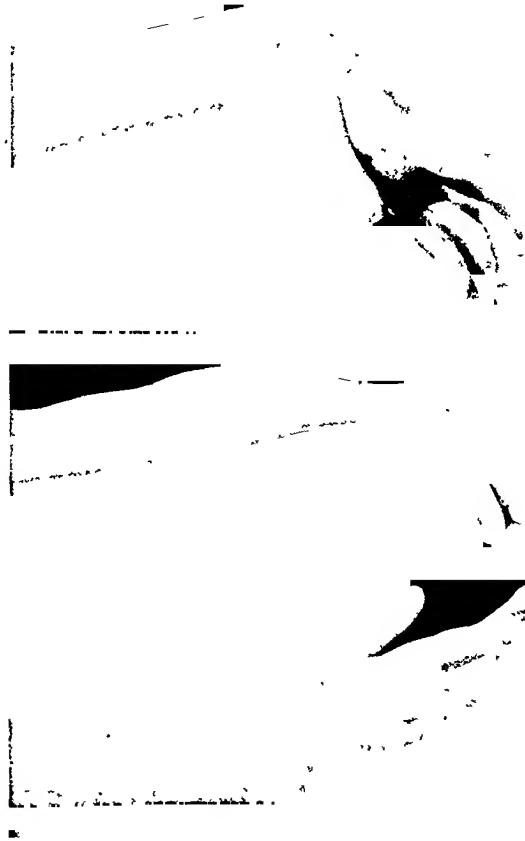


FIG. 16. Ischemic paralysis.

ation is the primary cause of most of the joint changes, there are many cases in which this is not so. Occasionally one may see an early arthritic involvement consisting of a painful swelling of the joint, which differs from the early inflammatory swelling of the wound itself. This may be persistent and last for weeks and be followed by partial ankylosis. At other times a gradual retraction of muscular tendons and hardening of the capsule of a joint occurs, sometimes associated with prolonged and

particularly improper immobilization, at times associated with prolonged suppuration. Very frequently one sees joint changes in painful and partial nerve lesions. They are characteristically

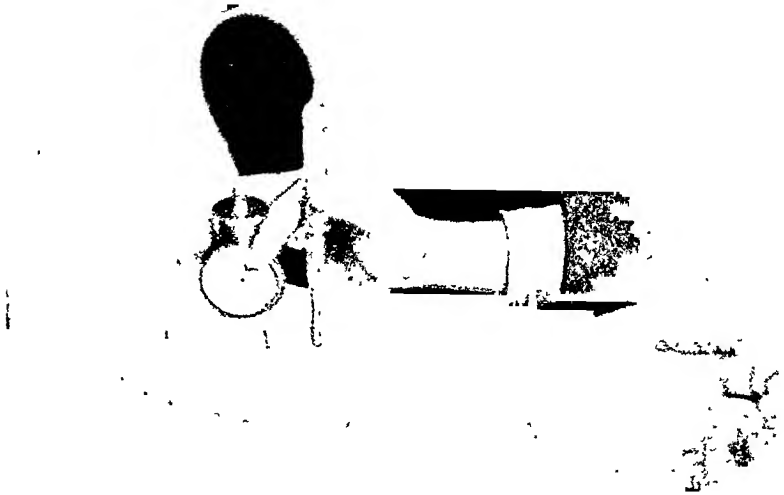


FIG. 17. Tonometer or sclerometer.

present in painful lesions of the tibial and median nerves, perhaps as a part of the picture of causalgia. These partial and painful lesions must consist of more than only a direct injury of part of a nerve. There is no more reason why a partial injury of a nerve should be followed by joint changes or ankylosis than a complete nerve injury, when in the absence of a suppurative lesion or immobilization, no joint changes may be present. They may possibly be associated with a definite low-grade infection which follows the lymphatics of the nerve to the joint (Fig. 14).

Injuries of certain nerves produce changes in certain joints peculiar to themselves. For example, injuries to the radial nerve in the middle of the arm are associated with ankylosis of the elbow. When this occurs early it is associated with a spasm of the biceps; when late, it is the result of prolonged suppuration or fracture of the humerus. In painful lesions of the median nerve the joint changes are notable, widespread and of severe

character. The interphalangeal and metacarpo-phalangeal joints of all the fingers are affected. At times, a partial ankylosis of the metacarpophalangeal joints of the thumb occurs and only



FIG. 18. Muscle atrophy in an ulnar nerve paralysis.

abduction and adduction is possible. As a result, attempts at extension produce abduction at right angles to the plane of the palm. The wrist joint and at times the elbow joint may be involved. What is true of the painful partial lesions of the median nerve is likewise true of the ulnar but to a far lesser degree. The interphalangeal joints of the foot may be involved in a partial painful lesion of the tibial nerve and limitation of passive abduction of the foot is often seen in peroneal lesions.

SHORTENING OF OPPOSING MUSCLES: This is not so frequently observed since the necessity of proper splinting has been recognized. Occasionally it occurs and offers retardation to recovery of function. Such shortening is commonly seen where deformities occur as the consequence of the force of gravity in addition to the overaction of unopposed muscles. For example, it may occur in radial nerve paralysis which affects the flexors of the wrist, in paralysis of the peroneal affecting the tendo Achillis and to a lesser degree in axillary

nerve paralysis, affecting the pectoral muscles (Fig. 15). Such shortening may occur even when gravity does not contribute to the deformity. For example, it may be the result of overaction



FIG. 19. Muscle atrophy in a median nerve paralysis.

of the extensor communis digitorum in ulnar nerve paralysis. Shortening may occur in the abductor pollicis and the extensor ossis metacarpi pollicis in median nerve paralysis; in the lumbricales in radial nerve paralysis; in the extensor communis digitorum in tibial nerve paralysis; and in the tibialis posticus in peroneal nerve paralysis.

Muscle shortening may at times result from a different cause; namely muscle *spasm*. This condition is usually observed in partial lesions of the peripheral nerves, or in muscles whose nerve supply may not have been injured primarily. In such instances they are the result of some irritative agent acting, perhaps, reflexly. Often they are associated with some vascular lesion. At times they occur as an accompaniment of a painful lesion of an adjacent joint or a bursa. For example, in arthritis of the shoulder or subacromial bursitis, a spasm of the pectoralis major is observed frequently. Muscle spasms should be clearly differentiated from the so-called physiopathic reflex nervous disturbances which occur without any lesion of a peripheral nerve and from lesions at a distance from the site of loss of function. Similarly, they must be differentiated from the fibrous shortening of ischemic or Volkmann's paralysis.

ISCHEMIC PARALYSIS: In addition to the paralysis due to the compression produced by bony callus there must be considered that which is produced by sclerosing fibrous tissue. In such cases there may be no symptoms suggestive of nerve injury immediately following the trauma but a few weeks later, particularly after the removal of a dressing such as a splint or a plaster-of-Paris cast, it will be found that symptoms of compression manifest themselves by partial or complete paralysis. In this group the largest number consist of those due to the formation of sclerosing fibrous tissue. This results from the organization of diffused blood or products of inflammation. The symptoms, particularly those on the motor side, are frequently confusing in relation to the diagnosis of a possible peripheral nerve injury. Characteristically, however, such a lesion is never limited to the distribution of the muscular supply of any one or more peripheral nerves. All the muscles in an extremity may be involved to a greater or lesser degree. The sensory changes are not definite and when they occur they too are not limited to the anatomical sensory distribution of the peripheral nerves or a combination of such nerves. The electrical reactions do not show the changes consistent with a pure peripheral nerve lesion. For example, one may find that certain parts of muscles supplied by an individual nerve may react to faradism whereas other parts do not. In general, it may be found that commensurate with the degree of fibrosis which has occurred there is a disappearance of both faradic and galvanic response from the muscles. Interphalangeal fibrosis with partial or complete ankylosis is very common. Coldness of the extremity and cyanosis are characteristic signs (Fig. 16).

TONE: When a peripheral nerve is severed the spinal reflex is interrupted in the motor arc and *loss of tone* results. If one were able to measure loss of tone accurately and if the degree of hypotonicity were an accurate indication of the severity of peripheral nerve lesions, it would be important that this function be carefully examined. Unfortunately, loss of tone occurs in partial lesions, as well as in complete lesions of

peripheral nerves. It is measurable only in the early stages following a wound to a peripheral nerve, inasmuch as later it may be complicated by other factors such as swelling, fibrosis and contracture due to fractures, infection or joint and vascular changes. When the secondary changes have disappeared frequently there is a resulting fibrosis or hardening which prevents an accurate determination of the tone of an extremity. The position of an extremity is not always an indication of the hypotonicity of the muscles, inasmuch as secondary shortening may prevent a wrist drop or a foot drop, for example. Tone may be measured by some objective method such as the employment of a tonometer which may be made rather simply (Fig. 17).

When measured in this manner it is found that soon after an injury of a peripheral nerve, in the absence of any changes such as swelling and inflammation, there is a marked hypotonia which may be measured in the amount of millimeters of mercury necessary to push the plunger a certain distance into a muscle mass. Whereas, in a normal muscle it may require 160 to 180 mm. of mercury, in a paralyzed one but 40 to 60 mm. of mercury is sufficient to plunge the indicator 10 mm. into the mass. Some time after injury this type of examination may prove to be quite useless. The subsequent atrophy frequently vitiates the result of the examination. Although one may find frequent references to the return of tone as an indication of return of function of a muscle, it has been found that the secondary changes prevent the observation of the return of this function. When observed, of course, it is a valuable sign, and if in a given case of radial nerve paralysis with a certain degree of wrist drop as the result of hypotonicity, the wrist is seen to assume an attitude in which it drops to a lesser degree, this may be accepted, in the absence of secondary shortening, as a hopeful sign.

ATROPHY: What has been said of tone is likewise true of *atrophy*. It has been accepted for some time that when a peripheral nerve is severed trophic disturbances occur in the

muscles which are followed by an atrophy of the affected muscle. It has been supposed that this atrophy is commensurate with the degree of injury of the peripheral nerve. Although

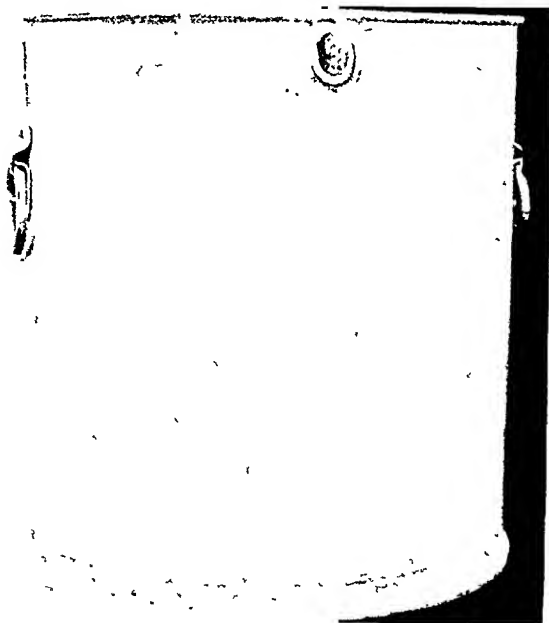


FIG. 20. Receptacle to measure tissue loss by water displacement.

this is true, we are unable to measure accurately the degree of atrophy so as to make it a valuable sign in differentiating complete from incomplete lesions. Extensive atrophy of a paralyzed muscle may be interpreted as meaning a severe lesion only with a number of reservations. Ulnar nerve lesions, as a rule, show extensive atrophy whether they are severe or not (Figs. 18, 19). Atrophy is of service in denoting the severity of a lesion only when seen soon after injury. The amount of atrophy observed some months after an injury is not commensurate with the severity of the lesion. Painful lesions of the median nerve and of the ulnar nerve are very frequently associated with rapid and marked atrophy. When observed some months after injury absence of demonstrable

atrophy is not an indication of a reparable lesion. Frequently replacement of muscle mass by other tissues is responsible for the seeming lack of atrophy, and no method of examination



FIG 21. Atrophy and lack of atrophy in sciatic nerve paralysis.

permits us to determine how much atrophy has been present. Inasmuch as peripheral nerve lesions are associated commonly with destruction of other tissues it becomes apparent that seeming atrophy of long muscles or muscle masses frequently may be the result of disuse or factors other than trophic changes in the nerve supplying that muscle.

If one measures the amount of water displaced by an atrophied extremity as compared to the amount displaced by the opposite normal one, some interesting facts are discovered

(Fig. 20). As compared to the unaffected extremity, the affected one in an irrecoverable ulnar nerve lesion shows an atrophy of 4.5 per cent of the total mass; in recovering lesions

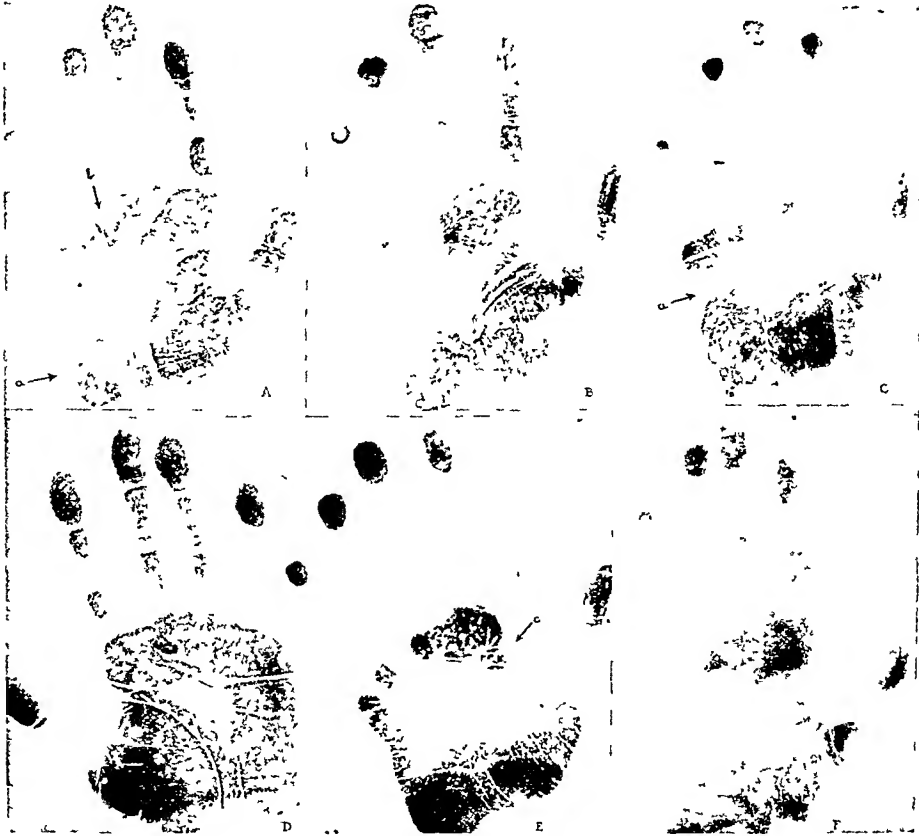


FIG. 22. Imprint of hand in ulnar nerve lesions:

A, Affected; B, affected, C, affected; D, normal, E, affected; F, affected.

a, Notch indicating atrophy of hypothenar muscles.

b, Notch between mounds of ring and middle finger indicating atrophy.

c, Break in line along radial border of base of index finger indicating atrophy of adductor pollicis.

4.2 per cent. In radial nerve lesions there is an atrophy of 4.3 per cent in recovering lesions and 5 per cent in irrecoverable ones. In lesions of the median nerve those recovering showed 11.2 per cent and those which were irrecoverable 50 per cent atrophy. In sciatic nerve lesions recovering lesions showed

9.7 per cent and those which were irrecoverable 10 per cent. In recovering lesions of the peroneal nerve there was 6 per cent atrophy and in the irrecoverable lesions 7.2 per cent.



FIG. 23. Imprint of hand in median nerve lesions:

- A, Affected, B, affected; C, normal; D, affected; E, normal; F, affected; G, normal.
- a, Disturbance of whorl formation at tips of index and middle fingers.
- b, Prominence of base of thumb, and notch in contour of radial border of thenar eminence indicating atrophy of thenar muscle.
- c, Loss of tissue along radial border of first phalanx of thumb.
- d, Failure of desquamation and presence of many new lines over thenar eminence.

Although the percentage of loss of muscle mass was slightly greater in the severe irrecoverable lesions, the difference was not sufficient to be of diagnostic or prognostic value. In addition to this, some irrecoverable sciatic nerve lesions showed but 1 per cent loss whereas a recovering one showed 17 per cent loss (Fig. 21). In a recovering peroneal nerve lesion there was found 16 per cent loss and in an irrecoverable one only 1 per cent loss. This immediately indicates that the demonstration of atrophy in terms of wasting of an extremity is not an accurate guide to the severity of the lesion. Although some

of the discrepancies are probably due to the replacement of muscle fibers by other tissues, it would seem in some instances that in those cases wherein exercise and massage, electrical

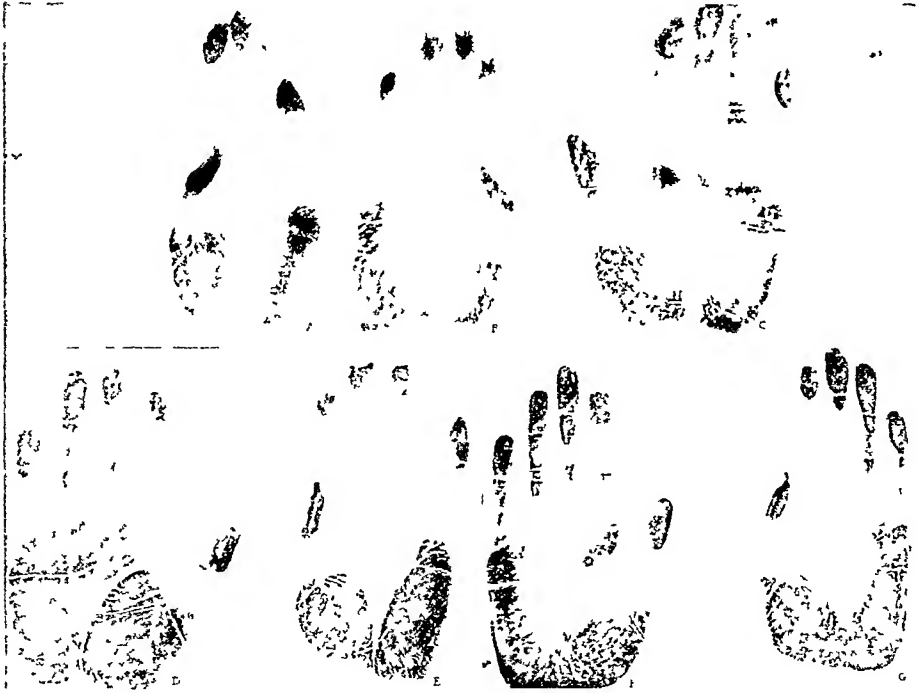


FIG. 24. Imprint of hand in radial nerve lesions.

A, Affected, B, affected; C, normal; D, normal; E, affected, paralyzed abductor pollicis, F, normal; G, affected.

stimulation and passive movement of the extremity was obtained the degree of atrophy seemed less. Whereas the ulnar nerve lesions show predominantly the greatest degree of atrophy which occurs rapidly, radial nerve lesions show the least amount of atrophy.

Graphic methods of recording signs and symptoms in many instances have a greater value than descriptive methods. Frequently it is impossible to have photographic records of the hands and feet in cases of peripheral nerve lesions. Under this condition it has been found serviceable to record the contour of the palm and sole by making impressions of the hand and

foot. The degree of atrophy and resulting deformity of the hand and foot indicate clearly the type of peripheral nerve lesion. Not only is the position of the hand determined but

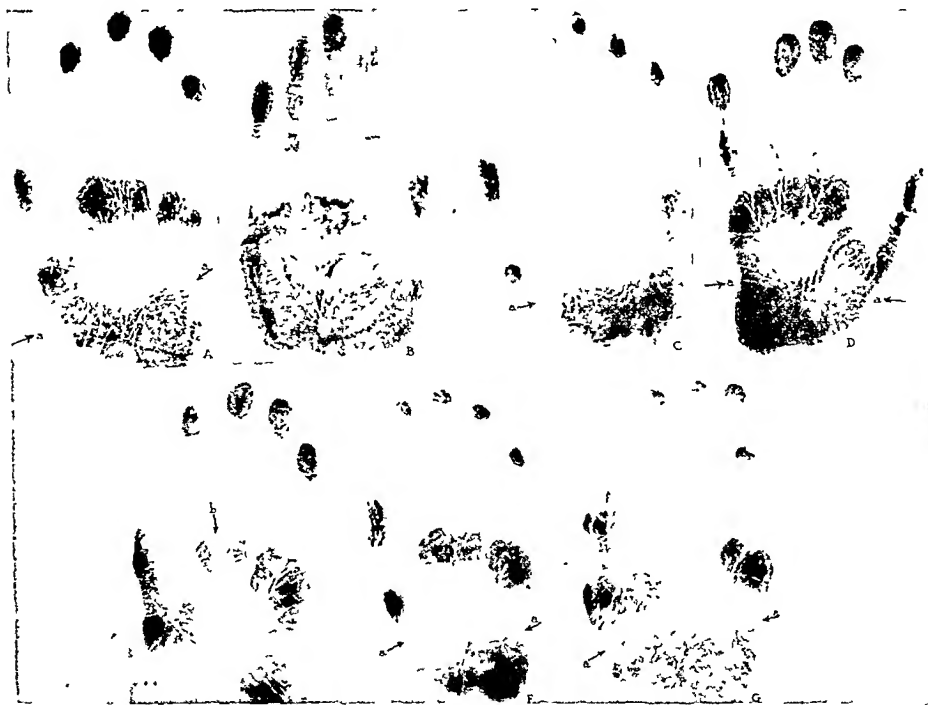


FIG. 25. Imprint of hand in combined lesions of ulnar and median nerves.

A, Affected; B, normal; C, affected; D, affected; E, affected; F, affected; G, affected.

a, Atrophy of thenar and hypothenar eminences.

b, Separation of mounds.

the atrophy of the muscles and contractures are shown as well. Only five of the peripheral nerves showed distinctive changes in a sufficiently large percentage to make it profitable to study lesions by this method. These nerves are the ulnar, median, radial, tibial and sciatic. The picture produced by a combined lesion of the ulnar and median is likewise distinctive. The imprint of the hand in the case of a lesion of the ulnar nerve shows the following characteristics: The clawing of the inner two fingers is well demonstrated by the absence from the imprint of any part of these fingers except the tip. The hypo-

thenar muscles are seen to be atrophied by the presence of a notch on what normally consists of a rounded contour made by these muscles (Fig. 22). Between the mounds of the ring

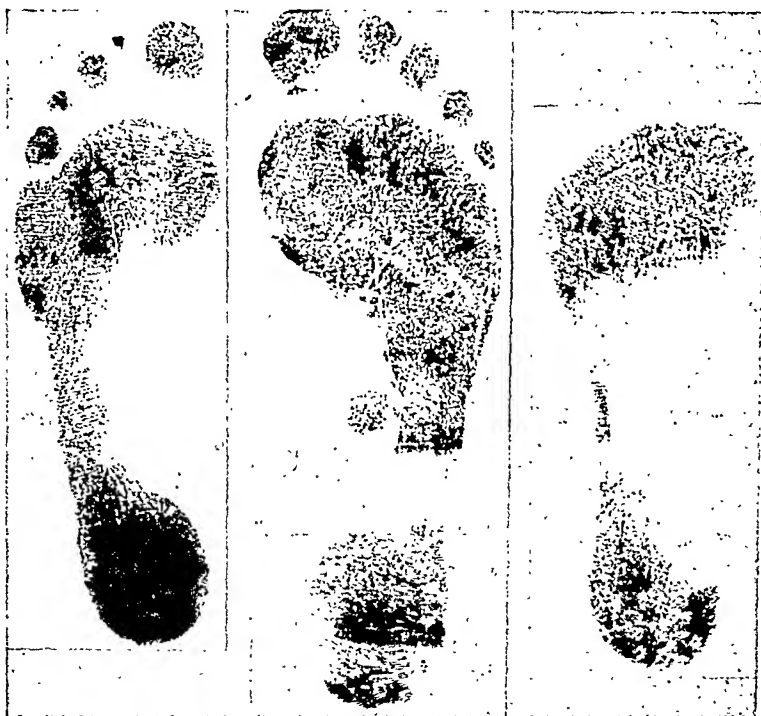


FIG. 26. Imprints of feet in peroneal and sciatic nerve lesions.

and middle finger is seen another notch, and when the atrophy is very severe a notch appears between the ring and little fingers as well. The fingers cannot be spread apart, and the first phalanx of the thumb is in a position of extension. The atrophy of the adductor pollicis is seen by a break in the line along the radial border of the base of the index finger.

Median nerve lesions show very clearly the disturbance of whorl formation on the tips of the index and middle fingers (Fig. 23). When severe clawing is present in these two fingers it is marked by the imprint of the very tip, frequently including the nail. The atrophy of the thenar eminence is usually well marked and is shown by the prominence of the base of the

thumb and a considerable notch in the normally rounded contour of the radial border of the thenar eminence. The distal phalanx of the thumb is in extension. When severe clawing is present it is made evident by the absence of any imprint of the central portion of the palm. Not only is the atrophy of the thenar eminence noted by the notches proximal to the base of the thumb, but in many instances loss of tissue is demonstrated along the radial border of the first phalanx of the thumb. Failure of desquamation and the presence of many new lines is demonstrated over the thenar eminence.

Radial nerve lesions are characterized by the cramped appearance of the fingers which results from inability to place the palm flatly on the paper because of the flexed position. The most characteristic feature of this imprint is the adducted position of the thumb. The distal phalanx falls within or on the border of the outline of the index finger. The thumb is rotated about its axis inwardly so that the radial border of the distal phalanx is straight and not rounded. The distal phalanx of the thumb is usually flexed. Absence of the signs of atrophy in the thenar and hypothenar eminences is an additional feature of this form of lesion (Fig. 24).

In combined lesions of the ulnar and median nerve signs of atrophy of both the thenar and hypothenar eminences are demonstrable by these notches found along their border (Fig. 25). Clawing is present in all four fingers. The mounds are often separated. The center of the palm shows a larger area in which no imprint is seen. When, in addition to partial lesions of the ulnar and median, the radial nerve is involved, the thumb shows at times the same rotation as was observed in the radial lesions. In lesions of the peroneal nerve there is frequently a flattening of the toes, so that the plantar surface of the entire length of the toes will produce an imprint. Lesions of the sciatic nerve show in addition a slight pes cavus and in some cases a clawing of the toes, indicated by the absence of their imprint on the paper (Fig. 26).

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THE PRESENT STATUS OF THE TREATMENT OF HIRSCHSPRUNG'S DISEASE*

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SURGICAL attack on megacolon through the sympathetic nervous system gives promise of continuing to produce the spectacular end-results which its introduction in a few properly selected cases heralded. The beneficial effects of lumbar sympathetic ganglionectomy and ramisection, as reported by Adson, Royle, Wade and others, prompted a report, by Learmonth and myself, before the American Surgical Association in 1930, of a modification of the technique of this operation, simpler and without influence on the circulation of the lower limbs.

We have now done either bilateral lumbar ganglionectomy and ramisection, or division of the presacral and inferior mesenteric nerves in eight cases, and we believe one or the other of these maneuvers to be the safest and surest surgical measure for relief of this type of pathologic condition of the colon. Even a cursory review of end-results of both medical and surgical treatment, the latter consisting of resection or drainage, or enteroanastomosis, discloses a high percentage of cases in which treatment has been unsatisfactory, due, no doubt, to the fact that all measures are attempts at restoring physiologic equilibrium to an organ that is without expulsive power, and incapable of emptying itself of huge accumulations of alvine discharges.

There are two types of giantism of the colon which are recognized as separate entities from the standpoint of etiology, and which yet are marked by identical pathologic changes. One of these is the true congenital type (Fig. 1) (the so-called Hirschsprung's or Myà's disease), and the other, the acquired type, which occurs later in life, and is due to a demonstrable obstructive lesion somewhere in the large bowel or rectum.

At The Mayo Clinic, since January 1, 1908, we have had 76 cases of megacolon, 11 of which were of the secondary type, 62 of the idiopathic type, and 3 of the acquired type secondary to carcinoma. Judd and Thompson reviewed 65 of these cases which had been treated by various medical and surgical procedures, and Adson reported 2 treated by lumbar sympathectomy. In 9 of the cases there were associated congenital anomalies, 5 of which were concerned with the anal canal or lower part of the rectum.

ETIOLOGY

The feature of megacolon about which there is most controversy is identification of a factor or factors which would result in this entity. Multiplicity of explanations, or, one would better say, hypotheses, attests the lack of knowledge as to the true cause. It has seemed sensible to us to epitomize the hypotheses under five general

* Read before the Interstate Postgraduate Medical Assembly of North America, Milwaukee, Oct. 19-23, 1931.

headings: (1) congenital defects, such as cause Hirschsprung's or Myä's disease; (2) obstructive processes, such as elongation



FIG. 1. Child, three years old, with typical appearance of megacolon.

of the mesentery, torsion of a segment, or multiplication of the intestinal loops; (3) anatomic factors, such as valve conditions, aplasia of the musculature immediately above the rectum, mechanical obstruction, and general systemic conditions; (4) infective processes, and (5) neurogenic processes.

Relief in certain cases of megacolon by lumbar sympathectomy certainly has strengthened the opinion that some of these cases unquestionably are due to derangement of the sympathetic nervous system. Our feeling is that there is a

mixed pathogenesis, that the best explanation of the cause of megacolon is that there are often several factors, in the sense that there is an embryonal defect which may be either in the motor mechanism of the bowel itself, or may be explained by ectasia of the intestinal wall, or there may be some mechanical, congenital defect which, although not demonstrably obstructive, produces the three cardinal anatomic features of colonic giantism, namely, dilatation, elongation, and hypertrophy. Attempts to demonstrate mechanical obstruction in the congenital cases have unanimously failed. Efforts to demonstrate faulty nervous mechanism in resected specimens have also been unsuccessful. Segmental spasm, achalasia, and so forth, are equally difficult to prove. The plausibility of the view that anatomic abnormalities, inflammations, or other conditions productive of stenosis, either of congenital or acquired nature, are predisposing factors, is obvious. The opinion that the gross pathologic features demonstrated universally in these cases are results of secondary changes due to some unexplainable and undemonstrable type of obstruction low in the colon, intrinsic, neurogenic, or mechanical, seems difficult to controvert.

PATHOLOGY

The pathology of congenital idiopathic dilatation of the colon (Hirschsprung's or Myä's disease) is the one feature about which there is little, if any, controversy. The description given by Hirschsprung, in 1886, of "a condition of congenital, high-grade dilatation of the colon with thickening of all its tunics, especially the tunica muscularis, and retention of large quantities of fecal matter," is still the most satisfactory word picture of the pathologic characteristics. The two changes, dilatation and hypertrophy, are universally noted in the affected segment, or in the entire colon if it is all affected. In about half of the cases, the condition is localized to one segment. Not infrequently, however, the entire bowel is affected; not a surprising

condition when it is recognized that this pathologic entity may occur in all portions of the gastrointestinal tract. It is unusual to find megacolon in the right half of the colon without its occurring in the left half or in the entire colon, but this occasionally has been noted. The sigmoid is affected in about half of the cases. Next in order of frequency of involvement are the following: the whole colon from the rectosigmoid juncture to the ileocecal coil, the hepatic flexure to the rectum, the cecum to the splenic flexure, the splenic flexure to the rectum, the transverse colon, the hepatic flexure to the sigmoid, and the descending colon.

The dilatation is huge, and in many instances increase in all the diameters of the colon, as well as of its mesenteric attachment, occurs to an almost unbelievable extent. Hawkins reported a case in which the circumference of the affected portion of the bowel was 110 cm., and Graves reported a case in which the whole colon was involved; the circumference was 31 cm., and the length of the affected portion was 110 cm. The circular and longitudinal fibers of the muscular coats are thickened and hypertrophied. There is little peritoneal change. There is, uniformly, elongation of the mesentery, with increase in blood-vascular elements and enlargement of the lymphatic chains. Elongation of the mesentery furnishes the necessary mechanics for volvulus, and this complication is not infrequent. Changes in the mesentery are of sharp definition and its engorgement and infiltration are accurately limited to the involved segment, unless the whole bowel is affected. The thickening at its base, near its juncture with the bowel, as well as its elongation, are characteristic.

Microscopically (Fig. 2), the picture of megacolon is constant; increased thickness of the mucous membrane and increased connective tissue elements, increased vascularity of the submucous coat, thickening of both muscle layers, and but few changes in the serosa.

When one performs exploration for megacolon of a patient who has been properly prepared for operation, usually



FIG. 2. Section through wall of megacolon. Inner muscular coat markedly hypertrophied; increased vascularity; mucosa considerably attenuated.

the dilatation has been reduced enormously but the hypertrophy continues to be present (Fig. 3). The line of demarcation is sharply defined if the condition of megacolon is segmental, but if it involves the whole of the large bowel, there is difference of degree in hypertrophy and dilatation in different segments. This is a point which has not been properly appreciated but which is readily explained by the mechanics of the condition. The symptoms of megacolon occur soon after birth, and, despite rigorous treatment, or with rigorous treatment to prevent their progress, advance into adolescence or even adult life. We believe the condition is progressive, and results from muscular efforts to pass the content of the bowel through a region of obstruction, either from lack of nerve supply or from some mechanical difficulty such as is produced by elongation of loops which, because of their condition, produce obstruction not recognizable when the

bowel is delivered. Numerous observers have explained the obstruction which occurs, but which is not actually organic,

dition are identical with those of the true congenital type.

In December, 1928, before the Western



FIG. 3a.

FIG. 3. *a*, Megacolon in sixteen-year-old girl, before treatment, *b*, same patient after medical decompression (refused operation).



FIG. 3b.

as being due to the weight of the ectatic and ptotic left half of the colon pressing on the underlying sigmoid, which is long and flexed. Such an arrangement obviously would not be found at operation, but theoretically it is a possibility.

The absence of demonstrable obstruction low in the colon has been the feature which has prevented satisfactory exploration. Occasionally, however, pseudomegacolon, if one wishes to call it that, may be produced by definite, organic obstruction; the pathologic changes in the latter con-

Surgical Association, one of us (Rankin) reported 3 cases of megacolon which were due directly to obstructing carcinomas of the lower part of the sigmoid or rectosigmoid. These carcinomas progressed slowly, and occurred in elderly patients who were not disturbed by progressive constipation, and who permitted the obstruction to advance until it was almost complete before seeking relief. Each of these patients had a hugely dilated and hypertrophied colon, filled with fecal matter; indeed, when the abdomen of one

of them was explored and the tumor was delivered, it was impossible to return the viscus to its normal habitat and resection was necessary, which, fortunately, resulted successfully. Grossly and microscopically, the changes in these cases paralleled in all respects those of the ordinary type of megacolon which we call Hirschsprung's disease. The mechanics are satisfactory; that is, there is an obstruction against which the bowel works without complete success in emptying itself, and with resulting hypertrophy of the musculature and dilatation of the segment that is immediately proximal to it, or the hypertrophy and dilatation may affect the entire colon. If one accepts the theory that a neurogenic abnormality is the deciding etiologic factor, the same type of productive factor is present, and this will not be demonstrable at operation or in a resected specimen.

OPERATION ON THE SYMPATHETIC NERVOUS SYSTEM FOR MEGACOLON

It is generally accepted that there is a dual innervation of the rectum and of the anus, with parasympathetic and sympathetic fibers. Fibers of the inferior mesenteric plexus end in the musculature of the colon and rectum, and carry impulses which inhibit its activity. Also, it is probable that these nerves exert a continuous influence on the tonus of the bowel. Experimentally it is easily proved, and, apparently clinically in man likewise, as demonstrated in Case II, reported by Rankin and Learmonth, that the thoracolumbar nerves give the motor supply to this muscle.

So-called sympathetic nerves to this part of the large bowel are derived from two chief sources: (1) the large ganglia in the upper part of the abdomen, celiac, semilunar, and renal, and (2) the paravertebral sympathetic chains. The former nerves descend on the aorta to the origin of the inferior mesenteric artery; the latter are contained in the mesially directed branches of the four lumbar sympathetic ganglia on each side. From the network of

nerves around the root of the inferior mesenteric artery, two large strands become separated. These pass out along the trunk of the vessel, and supply the colon with inhibitory nerves from the splenic flexure to the upper part of the rectum. The remainder of the preaortic network descends into the pelvis to join the hypogastric ganglia; inhibitory fibers pass to the rectum, and motor fibers to the smooth sphincter of the anus.

It has been shown by Learmonth and Markowitz that electric stimulation of similar nerves in the dog leads to dilatation of the colon and to contraction of the internal sphincter of the rectum, and contraction of the internal sphincter has been demonstrated by Rankin and Learmonth in the human being when the nerves are stimulated. It has also been shown by Learmonth and Markowitz that after cutting the sympathetic nerves to the colon of the dog, the activity of the bowel is greatly increased.

Various operative approaches have been devised for cutting these nerves. Wade and Royle make use of an extraperitoneal route, in which the lumbar sympathetic chains are reached through a long incision in the flank, after which the mesially directed branches from the lumbar ganglia are divided, and also the main chain itself, below the fourth lumbar ganglion. This operation, which usually has been performed on the left side only, reduces the sympathetic nerves by half, and has proved effective in a large group of cases. Judd and Adson have advocated resection of the second, third and fourth lumbar sympathetic ganglia, on both sides, through a transperitoneal approach. This operation is also curative. It interrupts a larger number of sympathetic fibers, but it has the minor disadvantage of depriving the legs of vasomotor control. In the operation reported by Rankin and Learmonth, the inhibitory nerves to the rectum, and the motor nerves to the internal sphincter of the anus, are first dealt with by resection of the presacral nerve, which is the strand

that conveys to the pelvis the nerves which have been mentioned previously. By following the central end of this nerve

upward on the aorta, the inferior mesenteric artery is reached; the inhibitory nerves passing along this vessel to the descending and pelvic portions of the colon are then divided. The operation severs all the sympathetic nerves to the parts of the bowel chiefly affected, and has the advantage of sparing the vasomotor nerves to the lower extremities.

ABSTRACTS OF CASES FROM THE MAYO CLINIC

CASE I. A boy, aged six years, was first seen at The Mayo Clinic June 13, 1931 (Fig. 4a). The chief complaints were distended abdomen and constipation. During the child's life he had passed a stool spontaneously only occasionally, and frequent enemas had been essential for any evacuations. The child was distinctly emaciated. All medical measures had failed to afford relief. A diagnosis of Hirschsprung's disease was made, the patient hospitalized, and suitable measures instituted for colonic decompression preparatory to operation. At operation, July 7, 1931, a typical megacolon was found, and bilateral lumbar ganglionectomy and trunk resection were performed. Peristaltic waves were at once observed in the colon, and flatus was expelled a few minutes later. Convalescence was slow but uneventful. Stools were soon passed spontaneously, and progress has been excellent to the present time (Fig. 4b). The patient weighs more than ever before and has normal stools with the occasional aid of mineral oil.

CASE II. A youth, aged seventeen years, was first examined in the clinic August 15,



FIG. 4a.



FIG. 4b.

FIG. 4. a, Boy, aged six years. Characteristic abdominal distention of congenital megacolon is shown; b, same patient, six weeks later, after lumbar ganglionectomy and ramisection.

1929. He had been severely constipated since birth, despite constant use of laxative diets, laxative drugs, and enemas. Roentgenograms gave evidence of an enormously dilated colon, and the diagnosis of Hirschsprung's disease was made. Following adequate medical measures, laparotomy was performed September 3, 1929. A typical megacolon was found and the lumbar colonic presacral nerves were resected. For a few days following, success of the operation appeared doubtful; however, three weeks later the bowels were moving well without the aid of any laxative. When the patient was heard from, about ten months following the operation, he was in excellent health and was passing stools daily.

CASE III. A boy, aged two years, was brought to the clinic May 27, 1927, because of obstinate constipation. The child had been constipated since birth and at times had suffered from large, firm fecal impactions, difficult of removal. Occasionally there were short periods of diarrhea. The child was poorly nourished and the abdomen was markedly enlarged. Following the diagnosis of congenital idiopathic enlargement of the colon, the usual medical measures were employed in preparation for operation. June 7, 1927, laparotomy was performed. Marked dilatation of the transverse and descending colon was revealed, and left lumbar sympathectomy and ganglionectomy were performed. Convalescence was without incident and normal bowel movements started within a few days after operation. Normal stools were occurring about one year later, although there was still some abdominal distention. The mother reported that the child had gained in weight and seemed "wonderful" in every way.

CASE IV. A boy, aged six years, was brought to the clinic November 7, 1927, because of constipation and enlargement of the abdomen. For one week following birth the child had had no stool and the mother stated that a normal bowel movement had never occurred. Daily administrations of laxatives and enemas were always necessary. A markedly distended abdomen and a greatly dilated rectum and sigmoid were the outstanding features of the examination. After a prolonged medical regimen, bilateral lumbar sympathetic ganglionectomy and ramisectomy were performed December 21, 1927. Dilatation and hypertrophy

of the colon started about 20 cm. beyond the hepatic flexure, and extended down to the rectosigmoid juncture. The postoperative course was unusually mild. Enemas were progressively more effective from the third day after operation; a stool occurred spontaneously on the eleventh day, and bowel movements were normal thereafter. When last heard from the boy was in good health, and was passing one or two stools daily with the aid of small amounts of mineral oil.

CASE V. A girl, aged eight years, was admitted to the hospital July 14, 1931, with the diagnosis of Hirschsprung's disease. For the previous five years there had been alternate spells of diarrhea and constipation. For periods of three to five months there would be no spontaneous stools, and daily enemas became necessary. The abdomen was distended and the child was underweight. A roentgenogram gave evidence of marked dilatation of the sigmoid, and moderate enlargement of the remainder of the colon. Following proper preliminary measures, the presacral and inferior mesenteric nerves were resected July 21, 1931. A stool was passed spontaneously several hours after operation. Postoperative convalescence was entirely uneventful. Two months later the abdomen was of normal size, the bowels were moving twice daily, and the child's general health had remarkably improved.

CASE VI. A youth, aged eighteen years, came to the clinic May 1, 1931, because of abdominal distention and cramps. Since the age of two years the abdomen had become progressively more distended. Abdominal cramps were frequent, and were relieved by passing of flatus. There was no marked difficulty with bowel movements. Laxatives were always ineffective. Roentgenograms gave evidence of huge dilatation of the entire colon, and of a large amount of gas in the bowel (Fig. 5 a). The presacral and inferior mesenteric nerves were resected May 12, 1931, and a typical megacolon was observed at this time. Mild infection of the respiratory tract slightly prolonged convalescence. Several weeks after operation stools were being passed spontaneously, and the general condition of the patient now is excellent (Fig. 5 b).

CASE VII. A boy, aged twelve years, came to the clinic October 30, 1930, with the diagnosis of Hirschsprung's disease. A promi-

nent abdomen was first noticed when the boy was three weeks old. Constipation had existed from the same time, and laxatives were without

the colon confirmed the diagnosis. Following suitable preparation of the colon, operation was performed September 4, 1931, and the



FIG. 5a.

FIG. 5b.

FIG. 5. a, Hugely dilated colon, characteristic of congenital megacolon; b, following division of presacral and inferior mesenteric nerves, absence of abdominal distention which was observed previous to operation is shown.

effect. Enemas caused great distress and their administration had to be discontinued. Examination revealed a poorly developed, undernourished boy, with extreme distention of the abdomen. November 7, 1930, the presacral and inferior mesenteric nerves were resected, and a hugely dilated colon was found, which was progressively larger from the cecum to the sigmoid. Convalescence from the operation was smooth, and a normal stool was passed on the fourth day after operation and daily thereafter. When last heard from, four months following the operation, the boy was gaining weight, was stronger than he had ever been before, and was passing normal stools.

CASE VIII. A woman, aged twenty-eight years, came to the clinic August 28, 1931, with the diagnosis of Hirschsprung's disease. The patient's father, who is a physician, stated that she had been constipated since infancy and that all laxatives, irrigations, and enemas had become ineffective. Roentgenograms of

hypogastric and inferior mesenteric nerves were resected. Recovery from the operation was uninterrupted. Enemas were at once effective, and flatus was passed spontaneously. The second week following operation a stool was passed spontaneously and gradually these have become regular and adequate.

COMMENT

These epitomes of 8 cases in which offensive measures were directed against the autonomic nervous system lend credence to the hypothesis that at least certain of these cases are indubitably of neurogenic origin. Physiologic basis for sympathetic neurectomy in congenital megacolon lies in the theory that the interruption of these sympathetic nerves deprives the bowel of the "brake" on its activity, and that the tonus of the internal sphincter is, at the same time, diminished, permitting

the bowel, thus, without opposition, to rid itself of its content. Broadly speaking, the sympathetic nerves are thus "filling" nerves, their preponderant action diminishing intestinal contractility and allowing it, in a more or less quiescent state, to accumulate its content. Section of these nerves thus is directed toward the essential pathologic characteristic of the lesion: namely, dilatation and hypertrophy. The former condition permits accumulation of intestinal content and the latter is the result of some type of obstruction. Granted that ideas of the etiology of this condition are somewhat nebulous, the disease may still be attacked by relieving the three outstanding anatomic features, and attempting: (1) to diminish the dilatation of the colon; (2) to overcome the excessive control by motor nerves, and (3) to relieve any opposition to expulsion of the content offered by the internal sphincter. The

accomplishment of the first two considerations is brought about by division of the inferior mesenteric nerves, and the third by division of the presacral nerves. This particular type of operation accomplishes these results, as evidenced not only by the 8 cases we are reporting but by numerous other cases noted in the literature and, at the same time, does not endanger the function of any viscera by interruption of important efferent or afferent fibers. The mechanism for defecation is not affected by division of the inferior mesenteric nerves. It will be noted that in the 8 cases recorded here, function was returned, tardily in some, it is true; nevertheless, neurectomy exerted a direct influence, and in all the obstipation and dilatation were overcome in varying degree. The safety of the operation and the desirability of its application in well selected cases, we believe, are established.



WILL BACTERIOPHAGE PROVE THE IDEAL WOUND TREATMENT? *

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SINCE time immemorial, infected wounds have been the surgeon's *bête noir*. One needs only to read Homer and Guy de Chauliac to realize this; and a review of wound treatment through the ages gives amusing evidence of the old adage that doctors differ, and proves again that scientific advance moves in cycles. The search for the ideal wound treatment is centuries old.

Primitive man's wounds were dressed "dry" with moss or fresh leaves, ashes or natural balsams, and when poisoned, treated by sucking and cauterization with red hot irons. The spear and arrow wounds of Homer's heroes were treated with healing ointments, pounded root, astringent, anodyne; but after any of these had been carefully applied, appropriate incantations recited with much religious fervor were considered necessary to insure healing. Religious influence was strong in medicine of the pre-Christian era.

Celsus, famous Roman surgeon in the reign of Tiberius, applied emollient salves to wounds and called on the gods to help. The Greeks invoked the aid of Apollo and Aesculapius.

In 1100 we find more faith in sucking infected wounds than in dressing them with emollients, the most notable example being that of Sybilla, beautiful wife of the Duke of Normandy, who, not caring to live if her husband died, sucked the poison from the dreadful wound in his thigh. She saved his life, but sacrificed her own.

Then came the Middle Ages; and the more repulsive the wound remedy, the more efficacious it was apparently considered. Crushed body lice and incinerated toads top the list of horrors. A powder made from Egyptian mummies and known

as "mummy powder" was extremely popular, as were herbs imported from the Orient, and therefore glamorous. Both were dissolved in wine or l'eau de vie.

In Mme. de Sevigné's day, psychic influence enjoyed a brief popularity. The soldier's wound was quickly washed and bandaged, and then the weapon which had inflicted the wound carefully dipped in wound ointment. The patient improved.

Digby did not treat the weapon, but ingeniously applied "sympathetic powder" to the soldier's discarded clothing at the point where the wound had soaked it in blood.

In Paré's time, it was a common thing for maggots to breed in a wound if the latter was left undressed for a single day; and the favorite precaution against wound infection was to pour into the wound tract boiling oil or molten pitch, in which elderberry bark had been dissolved.

Paré also seems to have given unusual importance to diet and the patient's comfort in the healing of infected wounds. Take the case of the Marquis d'Arnet, whom Paré treated for an infected wound of the thigh from an arquebus shot. The physicians who had been treating him for weeks before Paré was called had not changed the patient's linen in all that time for fear of disturbing the wound. Paré immediately ordered fresh clothing and bedding, made three openings in the thigh, took out bone splinters, cleaned the wound with boiling oil, put in drains, and applied plaster with a window.

But his treatment did not stop there. He ordered that the patient be fed a succulent diet of broth and herbs, wings of partridge, plums stewed in wine, sorrel, chicory, marigolds, and a list of delect-

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ables that would almost make one envy the Marquis his wound. Not only this; but for hours the patient was to smell flowers of herbane and water lilies bruised with vinegar and rose water with a little camphor. Artificial rain was to be produced to make him sleep. Viols and violin soothed him and a comedian was summoned by the doctor to make his patient merry. Is it any wonder that his convalescence was short?

A poet has paraphrased the after-treatment of wounds in those days:

Use three physicians still. First Dr. Quiet
Next Dr. Merryman, and Dr. Dyet.

By mere accident, Paré learned to doubt the efficacy of boiling oil as an anti-infectious agent. After a battle in which many soldiers were wounded, the boiling oil in the great kettles behind the lines gave out. Paré desperate for the welfare of his wounded, used a cold mixture of yolk of egg, oil of roses, and turpentine. Then he spent a sleepless night, worrying lest they die for want of boiling oil. To his surprise he found in the morning that these soldiers were in better condition than those whose wounds had been treated by the routine method. Thereafter he used the cold dressing.

The variety of ingredients used for poulticing infected wounds in different countries and different eras is amazing: herbs, ashes, blossoms and roots, bread and milk, linseed meal and boiling water, marshmallow water alone, or cold water mixed with saltpeter, vinegar and sal ammoniac.

Heister, a German army surgeon of the 1700's made a distinction between "ardent and phlegmatic temperaments," using poultices of vinegar for the former, and for the latter brandy or spirits of camphor—always some heating agency. In Heister's time, salves, plasters, vitriol, nitrate of silver, "lint," all had their advocates.

Gooch used a wax sheath to cover his wounds, and left them alone. If his technique were described in more detail

we might find a resemblance to bipp or the Orr treatment. At least he practiced the doctrine of non-interference.

The early German school, instead of salve-smearing, probed infected wounds unmercifully and filled them with quantities of lint. Würtz of Basel, in 1576, protesting against this method, said, "Medicines belong in wounds, and not such rags. The pus is thereby obstructed and cannot come out through the bolted door as it needs to do, and as Nature eagerly forces it." Nevertheless the probe-and-lint practice persisted for nearly two hundred years. Richter later adhered to the principle that Nature accomplished the healing, and all the surgeon should do was to remove grave obstacles.

Bell insisted on the free and unobstructed flow of pus, and to that end introduced lead tubes. In 1760, lead preparations for wound treatment were introduced in France by Goulard of Montpellier.

To the end of the 18th century the dogma of the injurious effect of atmospheric air on wounds prevailed. Hence the popularity of Paré's mixture of egg yolk, oil of roses, and turpentine: it hermetically sealed the wound. To keep out air, bandaging was done with lightning speed as soon as the salve-smearing process was complete, and the bandages changed "as seldom as cleanliness would permit." This does not mean 20th century cleanliness.

Hunter, in connection with his classic study of circulation and inflammation, remarked that it was sometimes "just as well to let a wound alone."

The 19th century was one of antiseptics and caustic germicides introduced by Lister. We are accustomed to think of this as a new departure; but more than two hundred years before Lister (1628) Woodall,⁶ an army surgeon, sharply attacked the "innordinate and meddlesome use of strong caustics." In his day, these were zinc and copper sulphates, mercurial salts, and sugar of lead.

Various balsams (of Peru, of Mecca, of white amber) also enjoyed popularity in the nineteenth century.

With the World War came the Carrel-Dakin treatment, the acme of antiseptics. It combined qualities which no previous antiseptic had: it did not harm the tissues, it dissolved the wound exudates, and permitted the nascent chlorine which it contained to penetrate to the bacteria in the recesses of the wound. I was one of its most enthusiastic advocates, having studied the details of the technique in Carrel's hospital at Compiègne, France. Subsequently, while Chief Surgeon at U. S. Gen. Army Hospital No. 3 during 1918 and 1919, I made a comparative study of this and other accepted wound treatments. The results of the Carrel-Dakin method proved so far superior that, early in the fall of 1918, I adopted it as the exclusive wound treatment. Of the 6000 serious bone cases which came under my care at this Army hospital, I can safely say that half owe useful extremities to conquest of wound infection by this method before reconstruction surgery was attempted.

But in spite of these excellent results, there were obvious objections to the treatment, and as the rush of war surgery abated, these objections gained more weight: The frequency of irrigation and dressings were distressing for the patient, arduous for the surgeon, and associated with risk of re-infection. It also necessitated prolonged hospitalization, a serious drawback to any treatment. The softening of the cast by the fluid and the necessity of cutting a window for insertion of the tubes rendered immobilization, so important in bone cases, imperfect; and also induced edema in the wound granulations and surrounding soft tissues within the area of the window, an unfavorable condition for wound healing. A uniform pressure over the wound as well as neighboring structures, such as is furnished by the Orr dressing, is most desirable. Under the Carrel-Dakin method, disinfection was in a sense working at cross purposes with

immobilization and with the ultimate goal, bone repair.

In 1923, Orr⁷ proposed a method for treating osteomyelitis which was the absolute antithesis of the Carrel-Dakin. For antiseptics, he substituted a vaseline dressing without germicidal power; instead of perpetual interference, he put on a cast and let the wound alone for weeks. For some time I hesitated to try this treatment; for, excellent as Orr's results were, the method seemed absolutely empirical and contrary to all previous conceptions of wound dressing and drainage. Finally, however, the annoying features of the Carrel-Dakin treatment of bone wounds, particularly its interference with immobilization, induced me to give the new method a trial.

I shall never forget with what trepidation I "unearthed" that first case of Orr treatment. The dressings under the cast were soaked with fetid pus. But as soon as the packing was removed and the wound wiped off, I was reassured by beautiful glistening red granulation tissue, as healthy as in the most satisfactory Carrel-Dakin treatment.

However much the vaseline and vaseline gauze method might seem to violate the traditions of free drainage, it was obvious that the process was sound. Soon after operation the patient's temperature had dropped to nearly normal and remained so during the eight weeks that the dressing was undisturbed. This fact and the healthy appearance of the granulations showed that instead of toxins being absorbed, they had been thrown off into the pus soaked dressings.

Orr's explanation (rest, immobilization, non-interference, and avoidance of re-infection), did not seem to me to account fully for the marked and unexpected success of the treatment, and observation of several cases convinced me that some unusual phenomenon was befriending both patient and surgeon.

In 1921, d'Herelle,⁸ a French bacteriologist at Yale University, claimed to

have found an ultramicroscopical parasite of pathogenic bacteria which had markedly beneficial effects in certain acute intestinal diseases, such as bacillary dysentery and cholera. This parasite he called the "bacteriophage" because it lived on virulent pathogenic bacteria and destroyed them, thus in many instances saving the patient's life. There were, he demonstrated by laboratory experiment, several varieties or "races" of phage, each with a preference as to the type of bacteria it would destroy; but also having certain adaptable destructive influences toward other strains of bacteria.

In the mass of detailed bacteriological findings which d'Herelle presented, two experiments struck me as having a definite similarity to what had happened in the Orr-treated wound, and to offer a possible explanation.

In one of his earliest experiments with dysentery bacilli he added about 0.0001 c.c. of bacterial culture to a young broth culture and subcultured the mixture immediately to an agar slant. Ultimately the surface of the agar was well covered with a roughened layer of the multiplying bacteria. Then, after a long period of time, two little islands appeared, two clear plaques perfectly circular in form where the agar was bare, entirely free of all traces of the bacterial colony. D'Herelle explained this striking phenomenon by the spontaneous appearance of a bacteriophage which absolutely destroyed the bacteria with which it came in contact.

To prove this, his next step was to apply a platinum loop to the roughened surface of the agar and transfer a bit of the bacterial colony to a test tube of clear bouillon and incubate it. Within a short time, the tube was so teeming with bacteria that it was turbid and opaque. D'Herelle then transferred to this turbid culture an infinitesimal portion of one of the clear plaques on the agar slant. After a few hours, the bouillon, as if by magic, became perfectly clear and transparent, and centrifuging of the culture failed to

disclose any bacteria whatsoever. Not only had all bacteria been killed, but their bodies had been lysed or dissolved.

Now if a chemical germicide had been placed in this tube or heat applied, the bacteria would have been killed, but at the bottom of the tube there would have been a sediment, a deposit as a result of centrifuging, millions of dead bacterial bodies. Not so in this tube of D'Herelle's. There was not a trace of sediment. Not a dead bacterial body could be found.

The analogy to the Orr treated wound is obvious. When one closes up the wound with vaseline, vaseline gauze, and plaster cast, it is teeming with infection. When one removes the dressing eight weeks later, the wound is clean and healthy. Whatever agent cleared out the offending infection appeared spontaneously as on d'Herelle's slant culture, for none had been introduced. And the long lapse of time, just as in his experiment, permitted this natural agent to carry on its bacteria-destroying action to a successful end. Was it not logical to assume that the phage principle had been working in the wound?

According to d'Herelle's deduction, certain races of phage were always present in the intestinal tract of man, but in varying amounts. Their parasitic activity apparently increased with the number and virulence of the bacteria with which they came in contact over a period of time.

D'Herelle also found that it was possible to increase and intensify this parasitic action by administering doses of phage culture, the additional phage being obtained from sewage. Isolation of phage in this manner is possible because the phage is so infinitesimal that it will pass through the finest filter after everything else has been screened out. The residual phage filtrate will of course contain many races in varying quantities. In order to isolate a given race in potent form, the bacteriologist introduces into said filtrate a culture of the bacterial strain on which that particular race thrives. The desired phage thus has an opportunity to gorge itself

with bacteria and multiply at the expense of the other races which have but a starvation diet. Before long, a pure strain of the desired phage persists.

D'Herelle's writings dealt chiefly with his laboratory work and with the treatment of intestinal diseases. Nothing had been said about bacteriophage in connection with osteomyelitis or the treatment of infected wounds.

But while I was searching for the cause of the unusual success of the Orr treatment, it seemed to me that practically the same conditions were brought about by the long and undisturbed dressing of the wound as occurred naturally in the old and attenuated bacterial culture in d'Herelle's test-tube. Was it not quite possible that a native bacteriophage had multiplied and become active under the long-continued dressing?

Pursuing this idea further, it occurred to me that the closest analogy existed between this phenomenon and the one which I had often observed in the citrus groves of my Florida estate. One of the orchard grower's problems is how to destroy the purple scale, which kills orange trees just as bacteria kill human tissues. There are open to him two methods of combat. He may spray his trees with a strong chemical which parallels the Carrel-Dakin treatment; or he may let a parasite fight the battle instead.

This is the red-headed ray fungus, a parasite which exists in orange groves by eating the purple scale. The threads of the fungus penetrate the body of the scale and eventually kill it as well as the eggs it contains. If the fungus does not of itself arrive in the grove, the gardener may import it. For certain other pests, he may introduce lady beetles if they do not spontaneously appear, as they often do. Fruit growers now seldom spray trees with chemicals to destroy certain pests if they can make use of a living parasite or natural enemy, for the latter method is much more reliable. In fact, some pests are more resistant to chemical sprays and

can only be eradicated by a natural enemy or parasite.

By careful laboratory search and tests, the race of phage which the surgeon needs for a particular case can usually be supplied if it does not appear spontaneously. In bone cases the specific phage for the para colon and staphylococcus are most potent. These we have checked in careful laboratory studies of cultures from infected wounds. Every bacterial smear that comes into the laboratory is tested to determine what phage will be effective.* In those cases where the phage does not spontaneously appear to work its beneficial parasitism in the wound, the laboratory-bred phage of the desired race is introduced.

In about 94 per cent of cases of acute and chronic osteomyelitis, a specific phage occurs spontaneously. In 3 of the remaining 6 per cent in which the phage does not appear spontaneously, the laboratory is able to supply us with a phage specific for the organism in question. But in the other 3 per cent, it has so far been unable to do so. This is particularly true of the *Streptococcus hemolyticus*, and in the cases where the bacterial smear from the wound yields this streptococcus, we have been forced to adopt the principle of watchful waiting. To our surprise, in several instances, the desired phage has later appeared in the wound spontaneously and healing has occurred. It is hoped that with the perfection of laboratory methods and increased knowledge of the phage, it may be possible to isolate races of phage specific for each bacterium. In that case, we would have the ideal wound treatment, an active living agent, capable of self-reproduction.

In order to accentuate and reinforce the effect of the spontaneously appearing phage, I am now introducing, in selected cases, a specific laboratory-bred phage. A report of the results of this combined method will be published later.

* Thus far our laboratory has been able to isolate twenty-five races of coli phage, four of staphylococcus phage and one of streptococcus phage. These we have used successfully in clinical cases.

The operative technique which should be applied to osteomyelitis, both acute and chronic, will be discussed here.

OPERATIVE TECHNIQUE FOR ACUTE OSTEOMYELITIS

In acute infectious osteomyelitis, the surgeon is confronted with active infection, necrosis, suppuration, and more or less general intoxication. The keynote of treatment is the immediate evacuation of pus, as indicated in any other pyogenic process.

For rapid and effective entrance to the marrow canal, the author has found his motor-driven instruments far superior in every respect to any hand tools yet devised. Multiple openings can be made into the marrow in a fraction of a minute by means of the large motor-drill. If pus is revealed by this procedure, the initial opening may be rapidly enlarged by the motor twin saw, which can be made to cut a trough in the bone of any desired dimensions. The ends of the trough can be cut with the cross-cut saw, and the portion of the cortex between the cuts pried off with a chisel. If motor-driven instruments are not available, the surgeon can use trephine, gouge, chisel, and mallet for this purpose. The opening into the marrow canal should be progressively enlarged until no more pus is evacuated; if necessary, the cortical lid should be removed from the entire length of the shaft, producing a gutter the length and width of the medullary canal.

The surgeon should avoid curetting the marrow, in order to preserve as much of the endosteum as possible for reparative osteogenesis and to prevent necrosis of the inner layer of cortical bone which is likely to follow its removal.

If the epiphysis is involved, a portion of its cortex must be removed for drainage, but the epiphyseal line should be avoided if it is possible to do so. If the joint also is involved, it should be incised, irrigated, and drained. The bacteria-resisting properties of the epiphyseal cartilage almost

always prevent invasion of the epiphysis. The entire wound produced by the operation should be thoroughly packed, from the skin margins to the bottom of the medullary canal, with yellow vaseline and vaseline gauze, and this efficient drainage of the bone should be maintained for three or four months, or until thorough sequestration has occurred and the periosteum has produced a sufficiently thick involucrum (as indicated by x-ray examination), at which time the sequestrum should be entirely removed. The packing and dressing should not be renewed until six to ten weeks later in order to secure the best effects from the spontaneous appearance of a specific bacteriophage or one that may be introduced by aid of the laboratory.

OPERATIVE TECHNIQUE FOR CHRONIC OSTEOMYELITIS

The extent of the bone lesion having first been determined from the x-ray, a suitable incision is made for its eventual complete exposure. Generally speaking, it is desirable to approach the bone where it is most superficial; but important anatomical structures may frequently debar this, as well as the danger of damage to peripheral gliding joint structures, or of induction of adhesions between them, or between important muscles and underlying bone. If a sinus persists, it is better, when possible, to include such infected tissue in the incision so that scar tissue and necrotic tissue may be trimmed away. When an incision is meant to include a sinus, a forceps or blunt-ended instrument, never a probe, is first inserted into the sinus to determine its direction and to serve as a guide for the incision. The incision should not follow the sinus unless, anatomically speaking, it is indicated. The incision is always made in the long axis of the limb, and is never carried through a muscle group, such as the quadriceps. It is preferable to follow the general line of cleavage between muscle groups. If there are any sequestra they are removed. For removing the cover of the sequestrum pocket, one

may use the single motorsaw, but as a rule, the osteotome is more practicable. Sufficient bone is removed to uncover the entire pocket, as only complete exposure will reveal its extent. The primary bone incision is carried beyond the line of demarcation of affected bone, if it has not separated. Overhanging ledges are removed until the sequestrum pocket takes on a contour simulating a saucer, or a perforating hole must be transformed into a valley with sloping walls by removing all bone from one side. This is important because as healing occurs, the contraction of cicatrization draws the soft tissues into close contact with the bone in precisely the same manner as a purse string, and the surgeon must make way for this important phenomenon. From this source, the adherent soft parts, the bone derives additional circulation and its healing and reconstruction are thus aided.

When I first tried Orr's technique, I applied it exactly, following the operative débridement and saucerization by careful swabbing of the wound with iodine and 95 per cent alcohol. But after I became convinced that d'Herelle's principle of bacteriophagy was largely responsible for the success of the treatment, I ceased using these powerful antiseptics, precisely as the grove men have done in their orange groves; because of the danger that chemicals may kill the beneficial parasite, or do more damage to it than to the pathogenic bacteria. Certainly if we are trusting to this active living agent to completely overcome the infection in our wound, why should we not view it in the same light as we do the lady beetle and red-headed ray fungus?

D'Herelle states that the phenomenon of bacteriophagy does not take place in the presence of antiseptics when the amount is sufficient to modify the state of the bacteria. One should, therefore, not use local antiseptics when bacteriophage is locally desired.

When saucerization and cleansing are complete, the wound is immediately

packed with sterile yellow vaseline and gauze soaked in an excess of the same. Since this dressing is semi-fluid at body temperature, it readily insinuates itself into the most remote recesses of the wound. The packing is allowed to overflow the wound so that it covers an inch or more of skin on either side. It is then covered with a gauze dressing and cotton padding, after which the limb is encased in plaster, and the joints above and below thus immobilized. No window is cut. The dressing is left intact for eight to ten weeks, at which time it is changed and reapplied after simple cleansing, unless the wound is entirely healed. This procedure is repeated until healing is complete. Sometimes the plaster is omitted at the second or third dressing, if healing is well advanced.

I previously⁹ suggested that some principle is retained in the wound by this method of dressing, which will, if undisturbed, contribute materially to the destruction of the infecting organisms. It is probable that this consists in part of the antibodies and living phagocytes; but the further suggestion was made that the specific bacteriophage accumulated in the wound if it was not dissipated too rapidly by irrigation or frequent dressing. There are thus two causes which may be suggested for the phenomenal results produced by this new method of dressing; one is mechanical and physiological, and the other is concerned with those newer principles of bacteriology which have to do with the nature and action of the bacteriophage.

After adopting the premise that a bacteriophage could be demonstrated in the wound after it had been enclosed in a dressing for some weeks, we conducted research to discover whether such bacteriophage was specific for any or all of the infecting organisms, and whether and to what extent the character of that organism was changed in the presence of the phage.

This work was conducted in the laboratories of the Post-Graduate Medical School

with the cooperation of Dr. Ward MacNeal and Miss Marjorie Patterson.

BACTERIOLOGICAL PROCEDURE

Pus obtained from the wound at operation or at subsequent change of plaster dressing was sent to the laboratory for culture examination. The visible bacterial flora were determined and a record made of the relative numerical predominance of the organisms present. The strains occurring in largest numbers were thought to be of some etiological significance in chronic osteomyelitis with which the host must cope for long periods of time and were, therefore, worthy of study. In a search for the presence of a lytic agent which might account for the clean appearance of wounds, it was first necessary to determine the susceptibility or resistance of these strains of bacteria to lytic action. This was done by subjecting them to the action of suitable stock races of bacteriophage of high titer. The fermentative reactions of organisms under study were determined at each examination as one means of identifying the same strain, or of ascertaining biochemical changes which might be brought about by environmental conditions in the wound. Broth cultures of the wound pus after twenty-four hours' incubation were filtered through Berkefeld N filters, and these bacteria-free filtrates tested for the presence of native bacteriophage. Since d'Herelle has shown that strong lytic principles isolated from the human intestine in health and disease may show action against few or many of the bacteria constituting the flora, known susceptible strains of the species corresponding to those present in the wounds were employed in addition to the wound strains in an effort to demonstrate readily the presence of lytic agents in these filtrates.

The excellence of the results makes this new method of wound treatment unquestionably preferred by all those who have experienced its advantages over former methods. Not the least of these is

its simplicity which results in economy of both patient's and surgeon's time, and of the former's money. In these days of "depression," one is duty-bound to consider the economics of medicine. Instead of remaining in the hospital for weeks or months after operation while repeated Dakin irrigations are carried on several times a day, the patient may leave the hospital in a week or ten days after operation. He can remain at home several weeks in congenial surroundings, free from the worry of hospital bills. When he returns for removal of the cast, the time required is so short and the reaction so slight that he need remain in the hospital only overnight, or in some cases only a few hours. Between visits, the surgeon's time and the hospital bed are free for another patient, an important consideration in any busy institution.

How markedly hospitalization is decreased by bacteriophage treatment is illustrated by a case of osteomyelitis recently referred to us from Baltimore. There the patient had been in the hospital for one hundred and five days under the maggot treatment, which failed to bring about healing. It is well known that the longer a case of osteomyelitis persists, the more difficult it is to treat. In this case we had to reoperate and do a fresh débridement and sequestrectomy before applying the bacteriophage dressing. Yet this same patient was hospitalized a total of only ten days from the time the first vaseline dressing was applied until the osteomyelitis was completely healed,—eight days after my operation and one day for each successive dressing.

To the surgeon about to repair the bone damage in an old gunshot wound with a history of infection, or any bone wound with such a history, re-lighting of a latent infection is his greatest fear. After any successful germicidal treatment, a little colony of bacteria may remain encapsulated in the tissue, quite harmless until the surgeon's knife unwittingly releases them. With what fiendish glee these

microscopic demons must watch the surgeon complete a meticulous piece of reconstruction, knowing that as soon as his back is turned they will start their irreparable havoc. The Dakin solution, because of its content of nascent chlorine, surpassed earlier germicides in reaching bacteria in recesses of the wound. But it did not always find them all. In bacteriophage we have for the first time an active *living* agent, seeking out these minute tissue destroyers in nooks and corners just as ferrets hunt down rats in an infested house. If poison is used, one is not sure that all the rats will find it and die as a result. Some are likely to escape and breed again. But ferrets, if left to pursue their hunt for a sufficient time, will rid the house of every rat. Will this active living agent, bacteriophage, in a similar way do away with latent infection? It is too early to say; but the fact that it lives and reproduces as its feast of bacteria progresses gives the surgeon hope that this may prove true. Certain it is that time is an important factor in the successful application of bacteriophage treatment. Shut up eight weeks to fight its battle beneath the cast, the phage has a good chance to achieve so certain a victory that the danger of future bacterial revolutions seems less likely.

Under such dressings, the phage develops spontaneously in about 94 per cent of cases of wound infection. The worse a wound being treated by bacteriophage smells, the better it may be doing. Sometimes patients beg to have the cast taken off because it stinks so,—a perfectly natural reaction, they think their wound is going bad. Instead, the wound granulations are growing more and more healthy. Indeed sometimes when the first cast is removed, the wound is practically healed; and to the surgeon who has seen the excellent results of this treatment, the foul odor is sweet.

Julian Huxley, the eminent British scientist, has recently commented¹⁴ on the elaborate system of checks and coun-

ter-checks by which Nature maintains its balance, and on the way in which man can use this same system to protect his interests and control his environment. Thus in Fiji, where the valuable coconut industry was threatened by a little moth who devoured the leaves of the palm trees, biologists searched the remote corners of the Pacific for a parasitic fly. This fly quickly reduced the menace to the status of a minor nuisance.

By other anti-pest organisms of Nature's creation, the sugar cane of Hawaii has been saved from its weevil destroyers; and massed battalions of lady-birds are successfully attacking the mealy-bugs which threatened the existence of Kenya coffee.

In my own citrus groves in Florida, as already related, I have often made use of a living parasite to protect the trees from destruction by the purple scale. This method of grove preservation is identical in principle to that which I have evolved in the treatment of infected wounds.

These few examples merely hint at the control of his macroscopic environment which man is exerting to an ever increasing degree. How great that control will become in the future we cannot prophesy. But, as Huxley says: "What grows on any part of the land's surface will grow there because of the conscious decision of man; and many kinds of animals and plants will owe not merely the fact that they are allowed to grow and exist, but their characteristics and their very nature to human control."

He speaks of Macroscopia. As amazing checks and counter-checks go on in Microscopia where bacteria wage their wars, and in Ultramicroscopia where the surgeon's new ally, bacteriophage restores healthy balance to infected tissues. Thus from the highest to the lowest organisms, and in every kingdom of the universe, Nature carries on her fascinating counterplay.

[For References see p. 247.]

SOME OBSERVATIONS ON OSTEOMYELITIS*

ISIDORE COHN, M.D., F.A.C.S.

NEW ORLEANS

DESPITE the great number of papers which have been written on the subject of osteomyelitis with reference to early diagnosis, it is rarely diagnosed early. All authors reiterate the formula by which a diagnosis can be made, yet few have the good fortune to present many personally observed real acute cases which they have treated. This sad commentary is responsible for the presentation of this collection of personal experiences for consideration here.

Didactic teaching and textbooks must of necessity be dogmatic in a measure based on ideals not yet attained. This is especially true with reference to the disease under consideration.

In this discussion an effort will be made to present the state of the development of the disease process when the individual cases first came under my observation. In one instance to be cited the patient was under the observation of a competent physician for two weeks. During that time a discussion of the x-ray finding delayed surgical intervention until a positive blood culture was obtained. In another instance a pathological fracture, secondary to osteomyelitis, prevented early recognition and proper handling. The diagnosis of pleurisy, pneumonia and of tonsillitis in other instances delayed early recognition of the disease.

I think all will agree that this evidence indicates that efficiently early diagnosis is the exception rather than the rule. I believe that the evidence indicates that operative procedures which are at times resorted to are incomplete, and that dangerous operative methods of approach which increase the risk to important vessels are too often adopted.

I am sure, when one considers treatment, that it is not necessary to adopt one of the recent ideal methods of treatment in order to obtain good end-results. I do not hold as true—once osteomyelitis, always osteomyelitis.

In order to develop the thesis only certain phases of the broad subject under discussion can be presented.

Diagnosis in very young children is at times greatly delayed. This is accounted for by the fact that painful extremities are often considered to be due to rickets, scurvy or syphilis, and many times the x-ray findings confuse rather than aid the attending physician. Of course it must not be overlooked that any one of the diseases mentioned may be coexistent with an acute osteomyelitis.

The following summary of 2 cases will serve to illustrate the point in question:

CASE 1. R. M. T., aged two months. The child had been ill for ten days before the mother noticed the swelling of the wrist. There was marked tenderness about the wrist, and the child did not use the arm with as much ease as she did the other extremity. The doctor in charge of the patient had x-ray pictures taken. These showed a destructive lesion associated with some productive changes. The pictures were variously interpreted; syphilis, scurvy, tuberculosis, osteomyelitis and malignancy were considered. The radiologist suggested that there was a well defined luetic process, and probably a mixed infection producing an osteomyelitis.

Several days later I was asked to see the child. At the time of my first examination, July 12 "the left forearm was larger than the right. The skin was slightly glossy, and red. Supination was limited. There was some infiltration of the soft tissues, both on the dorsal and volar surfaces of the forearm, and I got

* Read before the South Mississippi Medical Societies. Submitted for publication June 24, 1931.

the impression that there was an irregular enlargement of the radius. There was no limitation of motion in the wrist, elbow or shoulder.



FIG. 1. R. M. T., July 12, 1929. Radiologic diagnosis luetic ostitis and probably a mixed infection producing osteomyelitis. No. 84939.

There was no glandular enlargement. I would be inclined to believe, because of the destructive reaction of lesion and infiltration, that we are dealing with an acute infection producing a destruction of bone. I believe that at least an exploration of the radius is indicated and advise that an exploratory operation be done."

The doctor, whose patient the child was, believing that the entire condition was due to syphilis, ordered antiluetic medication and orange juice. Surgical intervention was not accepted.

A blood count, ten days after the child was first seen, was 13,000. The Wassermann reaction was three plus. The child's fever persisted. Subsequent x-ray pictures showed marked increase in the destructive process.

Twelve days after the child was first observed a blood culture showed a positive hemolytic staphylococcus. Twenty days after the first observation we were permitted to operate upon the child. We found the radius on both sides

diseased and a pure culture of *Staphylococcus aureus* was obtained from the pus.

This child made an uneventful recovery.



FIG. 2. R. M. T., July 22, 1929. Picture indicates progress of disease. No. 85120.

The x-ray pictures (Figs. 1-4) which are here presented show the marked improvement which followed. The child was last seen one week ago (May 28). The condition is excellent.

CASE II. H. H., aged three months. Breast-fed baby. The following history was obtained. The mother noticed that the baby cried when the right leg was handled, and that the baby held the right leg and thigh flexed. Temperature was 102.5°F.

Examination of the right leg showed a marked swelling causing the leg to have a fusiform shape between the knee and the ankle. The skin over this area was tense and shiny. There was no fluctuation. Movement of the leg caused pain. The other leg and arms were free from evidence of deformity or involvement.

The x-ray findings were reported as follows: "There is a fracture of the tibia in the upper

third. There is a marked periosteal reaction which is characteristic of lues."

The doctor who first examined the baby

The cortex of the tibia was removed for $\frac{3}{4}$ inch. Pus was found in the medullary canal.

Prior to operation an x-ray picture was taken

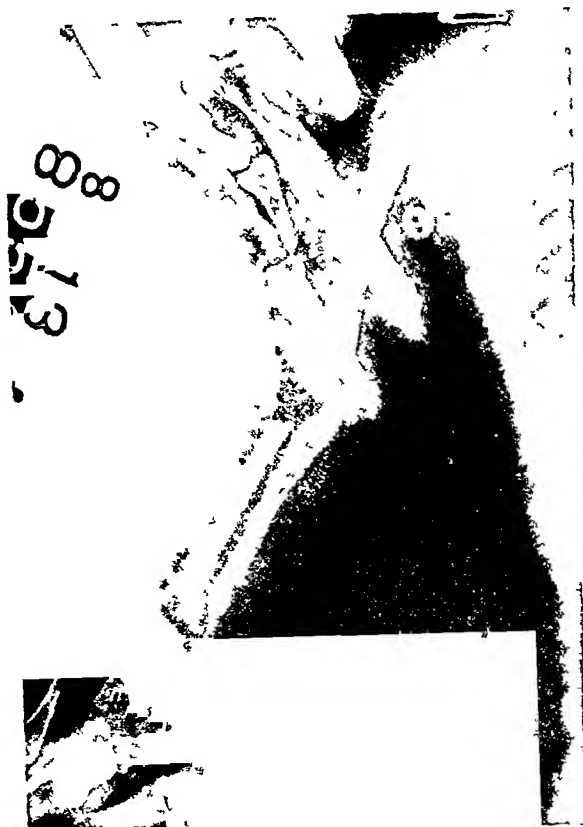


FIG. 3. R. M. T. August 13, 1929. Two weeks after operation. No. 85549.

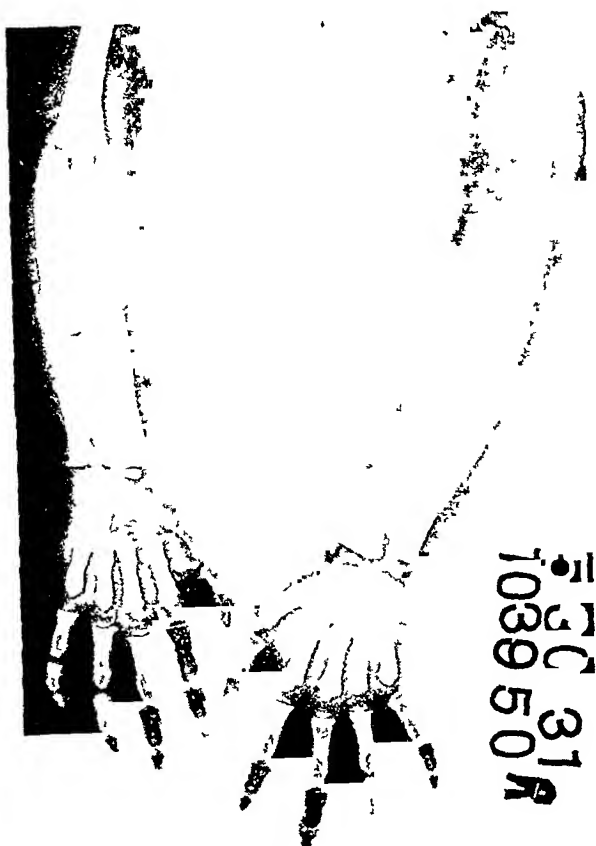


FIG. 4. R. M. T. May 10, 1931. One year and nine months after operation. No. 103950.

specifically stated that he did not think it a case of osteomyelitis. Anti-luetic treatment was ordered for the patient.

Four days later, when I first saw the child, the following notes were made. "The right thigh is flexed on the abdomen, and the knee flexed at a right angle. External rotation and abduction of the entire lower extremity. The leg and thigh on the right side are larger than on the left. There is some glossiness of the skin of the leg and foot. Palpation over the leg causes the baby to scream. There is an apparent thickening of the inner side of the shaft of the tibia. I believe that there is a slight fluctuation in the center of the mass. There is some edema of the thigh. The head of the femur rotates with the shaft. The deep femoral glands are enlarged. I believe that this is a case of osteomyelitis and accordingly advise operation."

Immediate operation was done. A subperiosteal abscess was incised and drained.

and an osteomyelitis was reported as being present. A coincidental luetic change was considered to exist.

X-ray pictures taken May 31, 1931 show a progressive improvement of the previously shown disease of the bone. There is almost a complete return to the normal appearance.

Comment: In these cases the clinical findings suggested osteomyelitis, the x-ray findings were variously interpreted. Syphilis was suspected and the idea persisted for over two weeks before surgical intervention was allowed. It is true that from the radiological standpoint there was good reason to state that the patient had congenital syphilis. In view of the recent observations made by MacLean, February 1931, the confusion in such a case would certainly

be increased for he states there is almost a unanimous opinion that in infants during the first weeks of life a deepening in the



FIG. 5. D. T. Osteomyelitic focus in lower portion of diaphysis.

longitudinal axis of the provisional zone of calcification of the long bones is indicative of syphilitic involvement. He also states that there is usually a rarefaction near the metaphysis; further that syphilitic osteomyelitis can be definitely diagnosed "roentgenologically" if the osteomyelitic lesions are symmetrical, and further that lesions are usually punched out areas with thickened contiguous supportive periostitis.

In Case I of this series the x-ray pictures presented all of these evidences. The patient did have congenital lues, but the

patient did not improve until the osteomyelitic foci, which were proved to contain *Staphylococcus aureus*, were surgically drained. Moreover, the patient did have a positive blood culture prior to operation. In both instances the diagnosis of osteomyelitis was confirmed at operation. The rapidly progressive destructive nature of the lesion indicated an acute bone infection. Much valuable time was lost in both cases because the classic picture was not present. It must be remembered that an infant cannot locate his pain for us, that gross differences in the size of the affected limbs may not be found and that syphilis, scurvy and rickets may be present in association with osteomyelitis. A pathological fracture such as was found in the case described here may coexist with osteomyelitis.

If we are to prevent prolonged illness, great destructive changes and crippling deformities, we must not wait in the case of infants. Early operation is comparatively easy, takes but a short time and the period of after care is greatly shortened.

Can we agree that too much has already been said on osteomyelitis and the need for early diagnosis when one sees cases such as the following:

CASE III. Master D. T., aged nine years. When the child came under my observation about two weeks after the onset of the disease the following history was obtained. The child had developed pneumonia three days after having played football on a wet lot. He had high fever and pain in his chest and abdomen. After the child had been sick for about forty-eight hours a doctor was called and a diagnosis of pneumonia was made. Three days later the patient had sudden severe pain in the right thigh and leg. X-ray pictures were taken and an operation was done on the leg under local anesthesia. *Some pus was evacuated and the crisis of the pneumonia safely passed.* A few days later the doctor told the mother that he would have to open the leg and scrape the bone. At this time the child came under my observation.

The child presented the appearance of one exhausted by sepsis (marked emaciation, anxious expression, hot dry skin, rapid

shallow respiration and a rapid thready pulse). We found a marked swelling of the entire

marked regeneration of the tibia which has taken place.

A year later the child returned with pain over

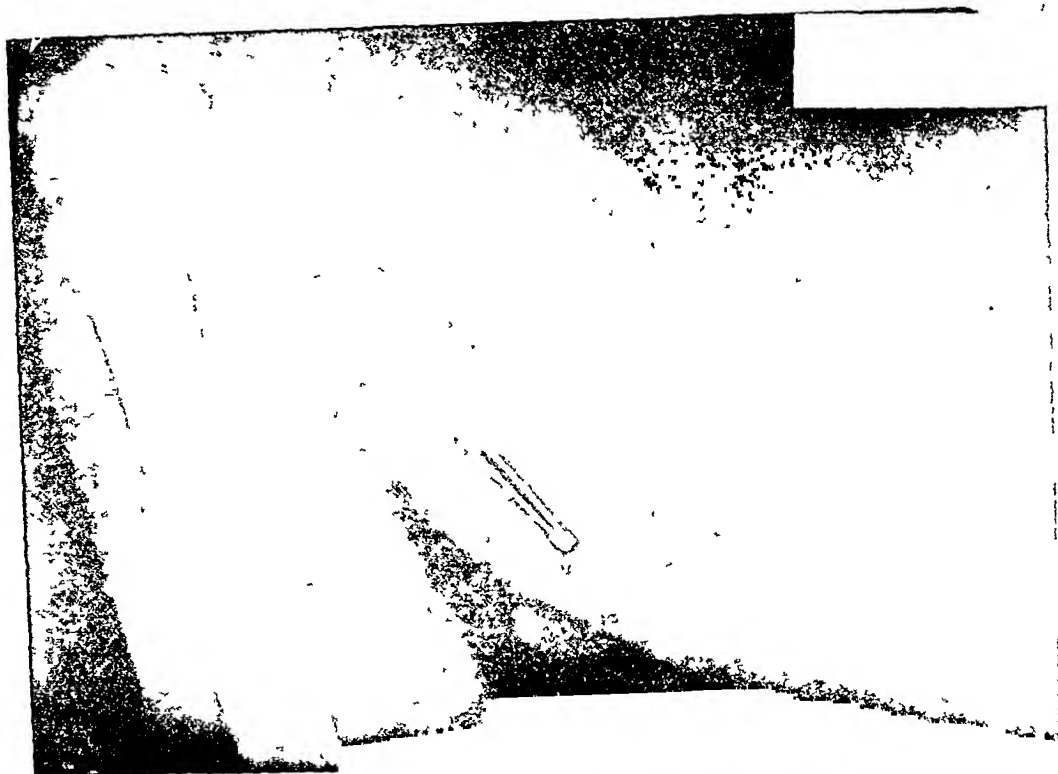


FIG. 6. D. T. Before operation, showing destruction of the upper portion of the diaphysis.

right leg from the ankle up to above the knee.

X-ray pictures at this time (Figs. 5, 6) showed a marked destructive process involving the upper third of the diaphysis of the tibia.

Immediate operation was done. We found that the upper $2\frac{1}{2}$ inches of the diaphysis of the tibia was so honeycombed that we felt that the best thing to do was to remove that portion of the tibia at once. With a motor driven circular saw section was made about $2\frac{1}{2}$ inches below the upper limit of the diaphysis. The cavity was packed. We also found that there was an osteomyelitic focus in the lower portion of the diaphysis of the tibia on the same side. With a motor drill we entered the medullary canal and there found evidence of diseased bone and a small quantity of pus. Dichloramine-r pack was introduced and a plaster cast applied.

The child's condition was so precarious that it was necessary after a few days to give him a transfusion. His convalescence was stormy, but his eventual recovery was excellent as evidenced by the pictures which show the

the wrist. We found evidence of an osteomyelitis of the os magnum, or capitate. The entire diseased bone was removed. The child made an uneventful recovery. He has not had to have, so far as I know, any subsequent operative procedure.

CASE IV. Master J. T., aged nine years. The child was first seen on the July 17, 1930. His illness began in November 1929, with an acute febrile reaction and pain in both lower extremities. For two months he was kept under observation because his tonsils were diseased. At the end of that time the tonsils were removed. The child continued to run temperature and this had been considered to be due to rheumatic fever. In June 1930 the family insisted on having x-ray pictures of the extremities because the child continued to complain of pain. The picture showed evidence of disease of the neck of the right femur and the lower portion of the left femur. The doctor who was in charge at the time operated on the child, making a drill hole in the shaft of the femur below the great trochanter. At this time

an incision was made on the inner aspect of the left thigh, about the middle third. His temperature persisted.

X-ray pictures were taken, blood count, and blood culture. The pictures demonstrated a progressive destruction of bone, involving the



FIG. 7. D. T. January 12, 1928. Osteomyelitis of os magnum (capitate) which was removed. Patient has been perfectly well since. No. 8395.

On July 17 the child was brought to New Orleans and was referred to Dr. Butterworth through whose courtesy I had the opportunity to see the patient. We found a tilting of the pelvis. The right thigh was much larger than the left. The right lower extremity was apparently longer than the left. We found an incision on the inner side of the left thigh above the knee in which we found a pack.



FIG. 8. D. T. June 14, 1928. Eight months after operation. Showing bone regeneration. No. 76210.

neck of the right femur with a proliferative osteitis. Just above the great trochanter the cortex had been broken through. There was evidence of a drill hole below the great trochanter.

The white cell count was 19,400.

It became necessary, because of the destruction of the trochanter and neck, eventually to remove all of the trochanter, neck and head of the femur. It was also necessary to operate upon the left femur where there was an osteomyelitic focus in the lower portion of the shaft. The subsequent course of this case which is still not a cured case by any means, has been stormy. During his stay in the hospital the

child developed an acute appendicitis for which it was necessary to operate upon him. Later the retroperitoneal glands became involved, he

produce. In both instances the profound anemia and the sepsis did look as though there would be a tragic end. It is true



FIG. 9. Mr. O. B. Showing extensive osteomyelitic involvement of practically entire radius except lower third of diaphysis. September 13, 1929.

developed a septic endocarditis, and at the present time is still running temperature as high as 101°F . For months his temperature ran as high as $103\text{--}104^{\circ}\text{F}$. daily. Several transfusions were given.

This child will be, if he survives, a terrible cripple. An early diagnosis, and proper surgical intervention probably would have cured this child in a very short while. Instead he represents one of the human wrecks which stand as a monument to late diagnosis, and as mute evidence of the great destruction that can be produced by osteomyelitis.

In summary then we see two tragic results which followed a diagnosis of pneumonia, and of tonsillitis. We witness, by the examination of these two patients, the ravages that septic processes will

they gave us an opportunity to see the beneficent effects of operation and transfusions. It also caused a great amount of undue anguish to the parents. Fortunately the first child has recovered and is well today. Early diagnosis and prompt surgical intervention would have cured both of these cases in a short while. Early diagnosis would have avoided extensive mutilating operations, and transfusions would not have been needed. The result in the first case indicates that regenerative processes will restore form and function.

The next case adds further evidence of the real need for early diagnosis.

CASE V. Mr. O. B. This patient was first seen September 17, 1929. Following is a brief summary of the history as I obtained it from the patient. Patient had pleurisy five weeks

before. Four weeks previous the left forearm began to swell. At this time an x-ray was taken of the elbow because of pain and some

the radius except the lower $1\frac{1}{2}$ inches. The operative record which follows is included because of the method of approach to the

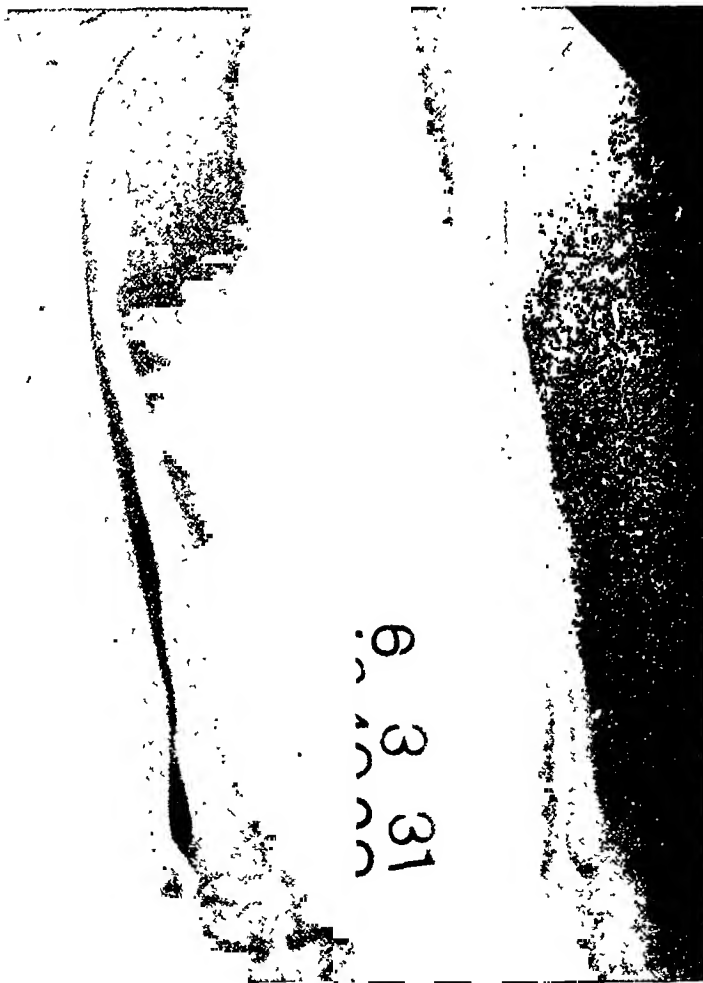


FIG. 10. Mr. O., B. One year and eight months after operation showing great amount of regeneration which has followed. Patient has never had a second operation. No. 104068.

swelling of the forearm. The picture showed no evidence of bone disease. After the first few days he was not confined to bed.

On examination, September 17, a diagnosis of osteomyelitis was made.

The patient was admitted to Touro Infirmary for operation. Prior to operation the median, radial and ulnar nerves were tested for their galvanic response. It was found that there was very little delay in the response. Prior to operation pictures were also taken. These indicated a destruction of almost the entire radius down to within about $1\frac{1}{2}$ inches of the styloid process.

Operation was done and this consisted in a subperiosteal removal of the entire shaft of

radius for a complete subperiosteal removal of the radius.

"Operation: A subtotal excision of the radius. Position of forearm, elbow flexed at right angles; forearm midway between pronation and supination. Incision made beginning at the level of the head of the radius, and at a point posterior to the insertion of the supinator longus, extending forward obliquely across the forearm, and to the middle of the forearm and then continued downward to the styloid of the radius. Muscles were separated. Inter-muscular planes found, radius exposed subperiosteally, bisected about the middle and with a lion-jaw forceps the upper fragment including the head was removed. Pack intro-

duced. Lion-jaw forceps applied to the lower fragment. It was decided, however, not to remove the entire lower fragment, but to leave the base of the radius with the hope that in that way, a useful wrist might be obtained. When the fragment was removed, the periosteum had attached to it, a long involucrum, about $\frac{1}{8}$ inch in thickness in some places and tapering down to about $\frac{1}{32}$ inch. Dichloramine-T pack was introduced and interrupted sutures were applied over the pack. Skin was closed with interrupted dermol sutures. Plaster cast applied, elbow at right angle, the hand was included, wrist in a cock-up position, or dorsiflexion."

The convalescence in this case was unusually smooth and the picture (Fig. 10) shows an amount of regeneration which had taken place up to the last time that the patient was seen.

June 3, 1931. Since last seen his arm has given him no trouble. The only thing he has noticed is that the arm has *become stronger*. He is able to drive an automobile. There has been no pain whatsoever.

Examination on this day revealed the left forearm to be smaller than the right. There is a slight bowing on the radial side. There is a scar which extends from the level of the external condyle obliquely downward to the styloid of the radius. The scar is about $\frac{1}{4}$ inch wide.

The patient is able to flex to slightly beyond a right angle and extend it about 150 degrees. Pronation is complete, supination to about 60 degrees. There is no limitation of motion about the wrist. The grip is excellent.

Comment: In this instance the patient was treated for a pleurisy. One week after the onset of the fever pain and swelling of the forearm attracted attention to the forearm, but since the x-ray picture did not reveal any evidence of disease nothing further was done. After another three weeks had elapsed a second picture was taken. It was then that I had the privilege of seeing him.

A radical operation had to be done. The entire radius, with the exception of the lower $1\frac{1}{2}$ inches, was removed superiosteally. Regeneration progressed very rapidly. No subsequent operations have had to be done.

Mention should be made of the method of approach. It has been my policy to follow the suggestions of the late James E. Thompson in the approach to all long bones. In this instance the forearm was kept midway between pronation and supination with the elbow flexed at right angles. The incision began at the level of the head of the radius, and at a point posterior to the supinator longus, extending obliquely forward across the forearm and then continuing down to the styloid of the radius, where we were thus able to get in the intermuscular planes. The radius was exposed subperiosteally. In order to avoid a great deal of dissection and damage to the soft tissues the radius was bisected about its middle, then with a lion-jaw forceps it was easy to remove the upper fragment, including the head. The remainder of the operation has been already described.

In the method utilized we were able to avoid extensive damage to muscles and important nerves, particularly the radial nerve. In the postoperative management of the case we were able to give the patient considerable comfort by having a moulded leather jacket made for the lower third of the arm and the entire forearm. I believe that all will agree with me that delay in diagnosis resulted in extension of the disease and necessitated an unnecessarily radical operation at a later date. Early diagnosis would have caused less disability, less pain, and less expense to the patient.

We talk of reducing mortality and morbidity in cancer, appendicitis, and osteomyelitis, and yet such calamities as these are mute evidence that our progress toward the goal is slow if at all sure. Too much dependence is still placed on x-ray pictures.

In the two preceding cases attention has been called to the regeneration which has taken place in these patients. Recently it has been my good fortune to see a patient on whom I did a complete superiosteal resection of the diaphysis of the tibia fifteen years ago. At the present time

there has been not only a complete regeneration, but the form of the tibia has been restored. This case presents so many



FIG. 11. Miss H. V. Fifteen years after subperiosteal excision of entire diaphysis of tibia. Patient has never had any further operative procedure. No. 102211.

interesting features besides the satisfactory regeneration, that a brief summary will be included.

CASE VI. Miss H. V. White female, aged eleven years? Patient originally presented herself to a surgeon who drained a subperiosteal abscess about her ankle. Five weeks later the patient came under my observation. At that time there were a number of draining sinuses on the inner side of the leg. X-ray pictures taken at this time revealed the fact that the

tibia was honey-combed from one end of the diaphysis to the other. A subperiosteal resection of the entire diaphysis was done. This patient has not needed another operation.

The original operation was done fifteen years ago. At the present time an x-ray picture (Fig. 11) shows a fully regenerated tibia. A synostosis has formed between the tibia and the astragalus, but in spite of this the patient dances, walks and carries on generally without discomfort. All of her ankle movements are accomplished through the astragalocalcaneal articulation.

The method of treatment utilized for the past eighteen years has been consistent. In the few cases in which a real acute condition has been found, at the time that the patient has come under observation, the following method has been utilized. A diagnosis is made in those cases which present a history of an acute febrile onset with pain as a rule localized over the shaft of one of the long bones. There is usually a marked leucocytosis. X-ray is not depended upon for diagnosis. The x-ray can be of service only when the disease has existed long enough for destructive changes to have taken place. Under no condition can the x-ray give definite information unless there is a difference in the density of the various portions of the bone involved. I believe that it is better to err when no osteomyelitis exists, rather than to delay and wait for definite x-ray changes.

Under general anesthesia an incision is made through the periosteum and a number of drill holes are made through the cortex, and if the disease is in that portion of the bone above the cancellous end of the diaphysis, into the medullary canal. Two points which I should like to emphasize right here are (1) that the presence of pus under the periosteum indicates that the operation should be extended to include drainage of either the cancellous portion or the medullary portion of the bone, depending upon the location. It cannot be emphasized too often that all pus outside of the cortex must have gotten there in a centrifugal manner. Drainage is the essen-

tial thing. The type of drug applied which is used is almost immaterial. With free drainage it matters little whether dichloramine τ or vaseline, or anything else is used. The advantage of an oily substance on the gauze is that it does not become adherent to the endosteum.

By way of digression I should like to insist that in acute osteomyelitis a curette should never be used because with the curette you destroy the very cells on which you are depending for regeneration. There is also a grave danger of injuring the nutrient artery, and if a clot is formed you are likely to have the entire diaphysis sequestrate. The application of a plaster cast has been our practice.

In later cases the amount of bone to be removed is dependent on the amount of evident disease. After the cavity has been loosely packed with dichloramine τ (since 1917) the pack is usually allowed to remain for five days, after which it is removed. If the pack is not removed the supply of dichloramine τ has been replenished.

The Orr method of treatment does not seem to me to meet surgical principles. While many are willing to accept the method, it does not appeal to me. The secretions which do accumulate irritate the skin and after a time the odor which emanates from the dressing is nauseating. With more frequent change of dressings there is less likelihood of concealed damage occurring.

It is not my intention to enter into a controversy with those who prefer putrefactive odors due to unchanged dressing, or with those who stand by and expect healing processes to be promoted by living scavengers in the form of repulsive maggots as advocated by the late Dr. Baer. Let me hasten to add that Bear did obtain good end-results by the use of sterilized well bred maggots; so do the followers of Orr, and so have we. The results are dependent more on the factor of prompt drainage of the infected and devitalized bone, than on anything else. The amount of destructive change is directly proportionate to the location of the embolus, and to the promptness with which drainage is instituted.



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* Continued from p. 236.

A FURTHER CONSIDERATION OF RADIUM & SURGERY IN CANCER OF THE BREAST*

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IN 1922, I read a paper advocating the use of x-ray and radium combined with thorough surgical removal, in cancer of the breast,¹ in other words, a radical operation after the method of Halsted and others, with radium and x-ray irradiation added. This method was suggested to me after a careful study had been made of what radium and x-ray irradiation would do, independently of surgery, in the treatment of cancer.

The best surgery done by the best surgeons in all parts of the world, results in about the same percentage of cures. The slight differences noted in the five-year cures reported, can be accounted for in the difference in classification of percentage of operability. Of course, the better and more radical the surgeon, the larger his percentage of operable cases.

Radical breast surgery has been so well developed that the mortality in the best hands ought to be less than 1 per cent. The peak of operative cures was reached sometime ago. Operative technique has been improved to such a point that some other agent must be introduced to give better results. The cautery technique, by either the electric cautery or the cautery knife, so-called, has contributed something, but even with these accessories surgery still needs help in order to materially increase the number of cures.

Earlier diagnosis has markedly increased the number of cures. Women have been so educated that they now go to their doctors earlier than they formerly did. Thus many patients are operated upon early enough to effect many more cures than formerly, even by surgery alone. This education of the lay public has advanced along with the improved operating ability of our

surgeons. It deserves credit for some of the improvement in our five-year cures. This has been noted by various writers, and must always be borne in mind in making our estimates of the value of the various methods of treatment.

I have suggested that radium and x-ray have probably come to establish the Fourth Epoch in the surgery of cancer of the breast.

In my first paper on the subject,¹ I advocated planting the radium at strategic points at the time of operation. This method, so far as I have been able to learn by a study of the literature, was the first proposal to put the radium in at the time of operation, and as a part of the operative procedure. All existing methods of pre-operative and postoperative irradiation consisted of applying radium or x-ray from without.

At that time, however, some users of radium did introduce needles into such growths of the breast as were regarded as inoperable. Boggs of Pittsburgh, advocated this method, and I presume there were others who did so. In December, 1927,² Handley of England, proposed planting radium as a part of the operative procedure. In May, 1929, I again presented a paper, advocating the use of radium and x-ray as adjuncts to surgery in cancer of the breast.³

I am venturing to emphasize again the use of radium as a part of surgery of the breast. I am doing so with a greater degree of confidence than formerly, since the method I originally proposed is being advocated in various parts of the world, and discussions of the method by high authorities have been appearing in medical journals since 1927, the latter date being the earliest I have noted. I actually began

* Read before the Southern Surgical Association, Lexington, Ky., Dec. 9, 1930.

the use of radium in 1919, making it a part of my operative procedure, basing my reasoning upon the following grounds:

quit talking about the "crab-like structure," which expression has unfortunately burdened the profession for so many years,

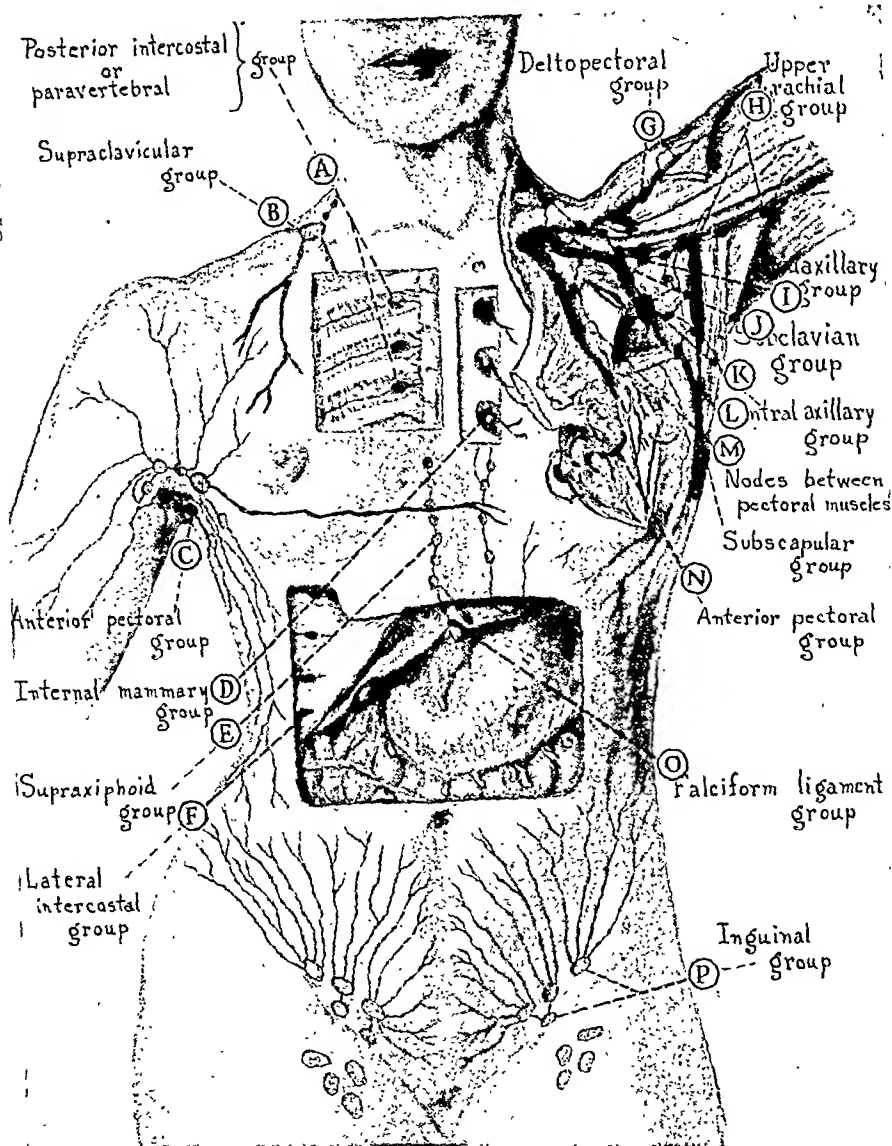


FIG. 1. Diagram showing lymph nodes of the breast and the lymph system with which they communicate. (Adapted from Deaver and McFarland's "The Breast and Its Anomalies," Blakiston.)

1. Surgery of the breast had reached the limit even in the hands of thoroughly competent surgeons. The peak of operative results had been reached and the average of cures by surgery could be improved chiefly in two ways:

(a) By the better education of the profession as a whole concerning the removal of lumps of the breast before they reach the stage of unmistakable cancer. Let us

and think in terms of malignant growths that are "finished" when taken completely away by any method found harmful and mutilating to a minimum extent. There is still much faulty teaching in our medical schools, textbooks and journals, concerning the diagnosis of cancer of the breast. When we get to thinking of lumps in the breast as potential cancers and remove them, we will make decided

advances. I have heard the best clinicians discuss the fine differential points between malignancy and non-malignancy of the the classical signs of malignancy (retraction of the nipple, shortening of the trabeculae, and the consequent puckering

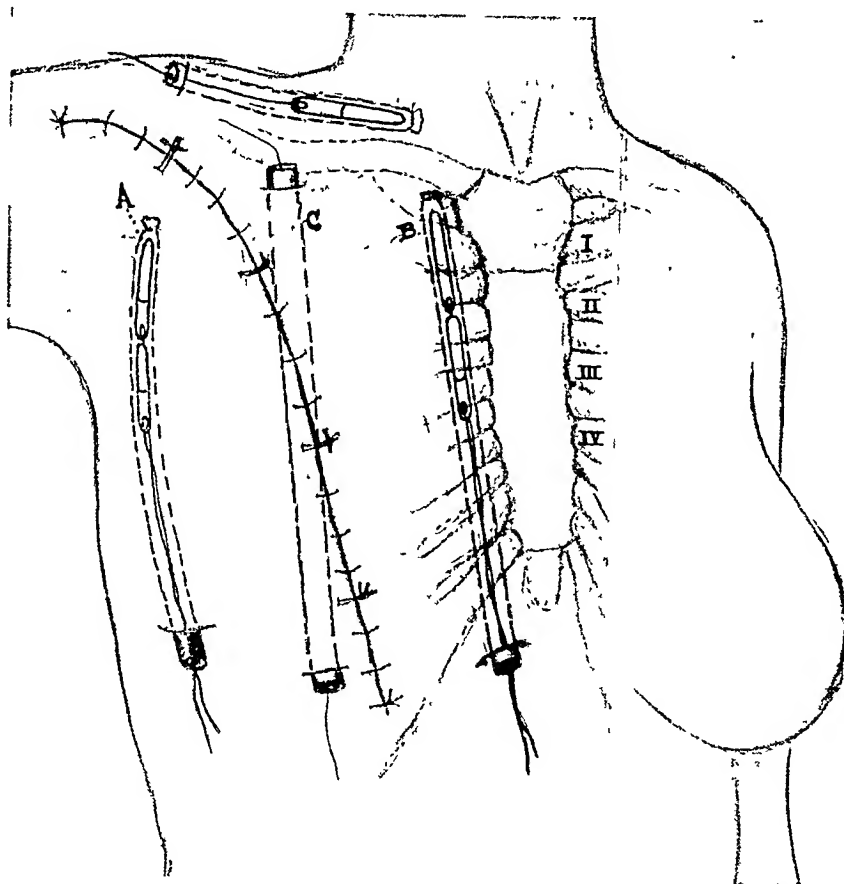


FIG. 2. Method as originally proposed in 1922 in applying radium. A and B, radium in position to be drawn down; C, tube in position through which radium may be drawn.

breast only to feel that I had received no information of value in the diagnosis of early cases. Then some clinicians give valuable information when the well-advanced cases are discussed. In my earlier days, I felt that these teachers had wonderful, even occult powers, but with experience and training in handling early cases, the conviction has come that occult powers are not possessed. Only a fair guess can be made by any of them, until the tumor is in the hand, cut out by that wonderful instrument, the "aseptic scalpel" which, as Deaver says, makes many a diagnosis. The time has arrived when we must regard every lump in the breast as possibly malignant, even though none of

of the skin and lymphatic gland enlargement) are present. Since these are late manifestations of the presence of malignancy, in order to avoid dealing with late cancer we must deal with the lump in its beginning, without hesitancy.

Surgeons must not be afraid now and then to make a mistake and remove a breast containing a non-malignant growth. This mistake must occasionally be made. Better to remove a breast containing a non-malignant lump than to leave a breast containing a cancer.

The surgeon must have at hand the means for diagnosing and classifying these growths in the operating theater at the time of operation, so that he may do a

conservative or radical operation, as may be indicated. Cutting out sections from growths for diagnostic purposes is dangerous, unless the section is made immediately.

given by those physicians who are consulted. Some doctors are poorly informed as to what can be done in cancer, and are so

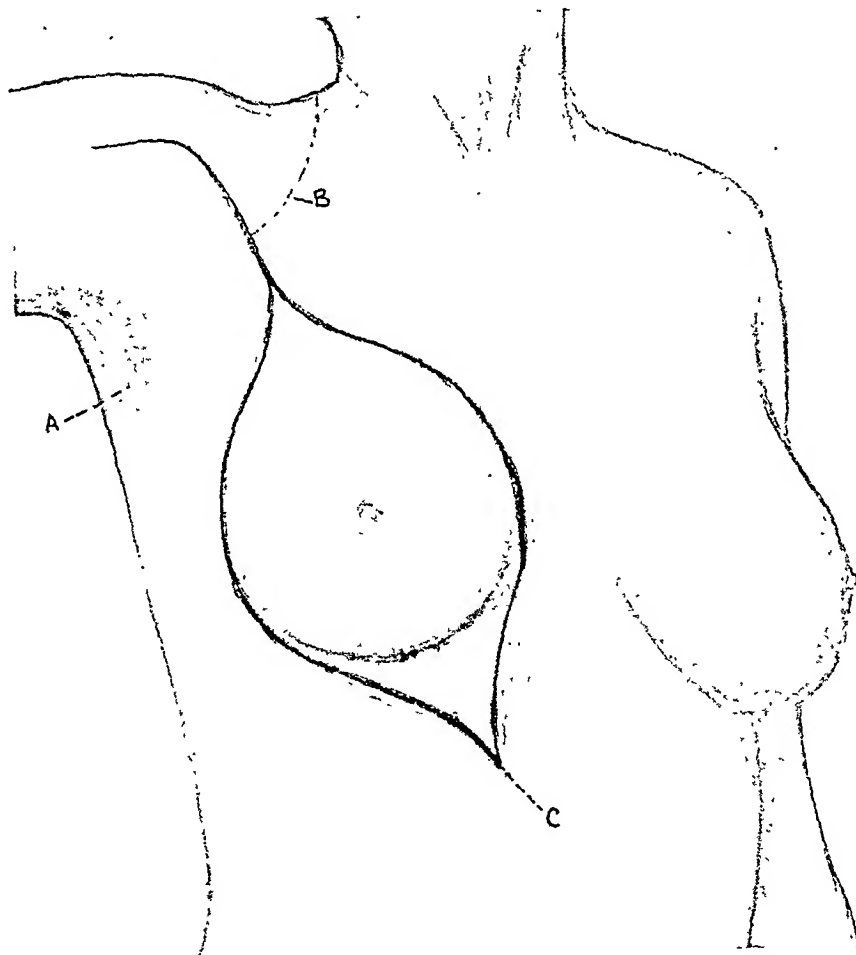


FIG. 3. Incision for radical breast operation. A, axillary glands; B, supraclavicular glands; C, epigastric glands.

gerous, unless the section is made immediately.

(b) The better education of the people through the many avenues of public health work and through personal contact with the medical profession, will cause patients to seek advice before there are any "crab-like structures" which are incurable, many times. In this way, through surgery alone, the percentage of cures can be raised, and already it actually has been raised.

We are constantly confronted with patients who decline to take the advice of competent physicians as to the best treatment in any particular case. This is largely due to the great variety of opinions

pessimistic that the patient hesitates to do what the really competent physician advises. To many, a doctor is a doctor, regardless of how ignorant and incompetent he may be. We must teach women that a lump in the breast necessitates a visit to her doctor, and in turn we must teach her doctor that such a lump is better out than in; that more often than not, this is the only way such a lump can be definitely proved non-malignant. Failure to obtain this information may be fatal.

As the progress of education goes on, the public is learning how to determine who is and who is not competent, a hard lesson, but they are learning it; hence the surgeon

sees many early cases that are not only operable but curable.

2. I had observed that radium and x-ray

radium into contact with the cancerous growths was one of the serious handicaps in its use. The skin not only interfered

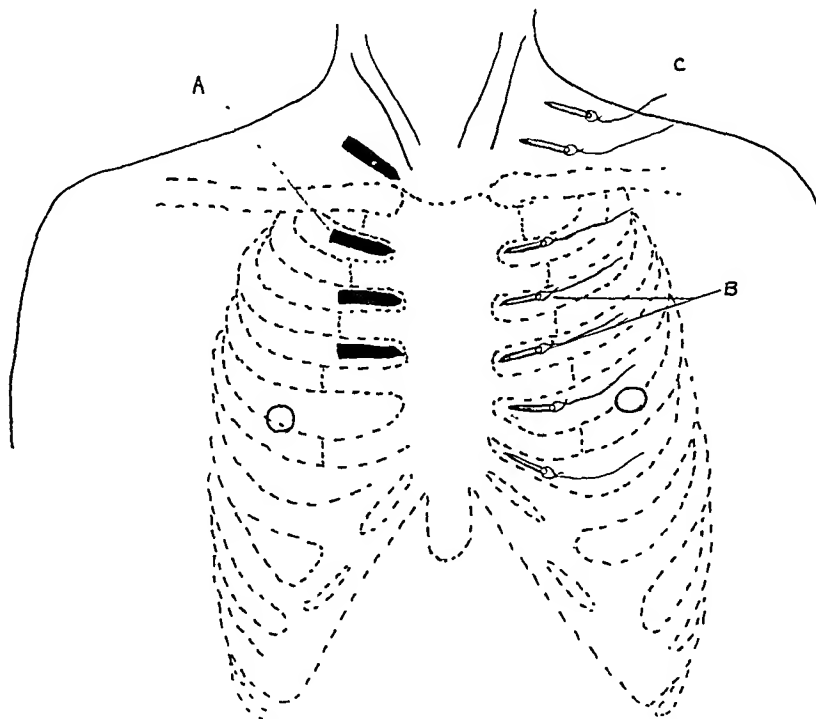


FIG. 4. Uses of radium. A, capsules of radium in place (after Handley, 1927); B, author's use of 10 mg. needles as practiced now; C, for supraclavicular region.

radiation were giving us some rather striking cures, even in seemingly hopeless cases. Kelly, Boggs, Pfahler and others, had exhibited such cases back in the days when some of our good surgeons poked jokes at them concerning their work. These pioneer advocates of radium and x-ray had succeeded by the use of ridiculed agents, in bringing past the five-year period some of the discarded cases of those same surgeons. Incidentally, some of the patients are now past the ten-year period, alive and well.

Having observed that surgery had apparently reached its peak of cures, even with its improved technique in careful dissection, by knife and cautery, and that radium and x-ray had demonstrated their potency in aiding and curing cancer, I began to strongly consider a combined method of surgery and radium radiation. It seemed to me that the failure to get the

with the penetration, but it would stand only a certain amount of radiation. It was necessary to determine the amount of radiation, with certain filters, that the skin would stand, hence we came to calculate in terms of skin units, or what the skin would stand.

Finsterer of Vienna, whom I saw operating in 1913, while attending his clinic, attempted to surmount this difficulty by exposing the growth so that the x-rays could play directly upon the tumor. Recently, x-ray radiation of the operative wound before closure, has been advocated.

Thinking of Finsterer's method, I conceived the idea of putting radium directly into the tumor, after surgical exposure or, better still, to remove the growth as radically as possible by good surgery, and then place the radium at the most strategic points, for a sufficient period of time to

destroy cancer cells beyond the reach of the knife alone.

After operating in this manner upon quite a number of cancer patients, and finding that, apparently, the results were far better than by surgery alone, I hesitatingly read a paper before my State Society, as already stated, advocating the method. I have continued the use of radium, as proposed in this paper. I have carefully scanned the literature for reports of similar plans of attack. I may have overlooked some references, but I saw nothing of the sort proposed until December, 1927, when the report of Handley, already referred to, was published. This paper gave me much pleasure, for the author pointed out very clearly its distinct value in his own experience.

I have modified my original technique in keeping with the teaching of the Radium Hemmet of Stockholm and of Regaud of Paris, and of others who follow their methods in regard to the amount of radium used and the time of exposure, but I have adhered to the main plan of using the radium as an adjunct to surgery except in cases too far advanced for surgery. In such cases I have used buried radium needles and x-ray without surgery, which practically all surgeons now advocate as a palliative procedure.

I published a paper in 1929,³ again advocating radium as an adjunct to surgical treatment, hoping thus to get others interested in the method.

In June, 1930, W. Turner Warwick⁴ presented a paper under the title, "A New Technic Combining the Use of Surgery and Radium in the Treatment of Cancer of the Breast." He reports a series of cases and closed his paper by saying: "The series was reported because the results attained appear to establish the possibility of a more extensive attack on local and lymphatic spread by the combined use of surgery and radium than can be achieved by either alone." His method of applying the radium needles is certainly excellent. However, I do not agree that it is necessary

to apply the needles along the entire intercostal spaces, as he does. His discussion of the principles upon which he proceeds is clear and to the point, and with these principles I agree completely. As his post-treatment observation period was only from December, 1928, to June, 1929, his cases could not be reported as cures. His method is almost identical with mine.

I am pleased to note that our own Hugh Trout,⁵ has been using buried radium at the time of operation. He reported his work to the American Medical Association, November 1, 1930. His technique is practically the same as suggested in my original paper, in 1922. I vary this technique now, since acquiring radium needles, and will probably modify my method somewhat. Dr. Trout reports 22 per cent of his patients operated upon from 1909 to 1920 as alive and free from recurrences for five years, and this without radium. In 1920, he began placing radium tubes in the field of operation. This practice resulted in 30 per cent of five-year cures. In 1924 he added high voltage postoperative x-ray therapy producing apparently 55 per cent of five-year cures. These results, I believe, are in line with the results of others, but here again, confusion reigns, because there are so many factors that enter into any consideration of five-year end-results.

Confusion of mind reigns supreme when one attempts to analyze the pros and cons of the use of radium and x-ray in the treatment of cancer of the breast. Order, in a way, seems to be coming out of chaos as the knowledge of the use of these agents is more definitely worked out, and a more definite language is being spoken by the different writers.

F. W. O'Brien⁶ suggests that until we establish and maintain tumor clinics where a common language is spoken, we will hardly be able to judge the comparative value of the different methods used in the treatment of breast cancer. We know that there is a definite trend toward a better appreciation of radium and x-ray in the treatment of cancer of the breast, and

there is a growing group of physicians who believe that surgery will be displaced by radium in the treatment of cancer of this organ.

Along this line, Geoffrey Keynes⁷ of St. Bartholomew's Hospital, London, writes very strongly. He has worked out a plan of introducing needles after the method of Boggs of Pittsburgh and, in addition, uses a battery of needles in Columbia paste, which acts in a similar fashion to radium packs. He says: "I am persuaded that in the early cases, radium is the treatment of choice."

B. J. Lee,⁸ of the Memorial Hospital of New York City, gives his conclusions as follows:

1. The treatment of carcinoma of the breast by irradiation alone, or combined with radical surgery, gives a higher percentage of five-year results than radical surgery alone.

2. Preoperative irradiation adds to the percentage figures of five-year results.

3. Postoperative irradiation has increased the five-year results.

I have searched the literature for the past ten years. It would be interesting to refer to many writers, but I cannot do so for lack of time. Much of the material is useless, save that it shows how great has been the struggle toward the solution of the problem.

I have become thoroughly converted to the use of radium as a part of the surgical procedure in operable cases of cancer of the breast. I have regarded all cases as operable that showed no general metastasis, and in which the patients were not too infirm either from age or disease.

The following was my original method:

Incisions for a radical operation were planned after the method of Halsted, Warren, Rodman and others, but most often that of Halsted was employed. Where the growth was not definitely cancerous I sometimes used an incision proposed by Warren, in which he went below the breast, removed the growth, and if it was found benign the breast was

not sacrificed. This incision on the under surface of the breast is far less conspicuous and therefore more preferable when dealing with a benign lump. If the growth is definitely malignant, the radical operation is performed, removing the breast, axillary glands, areola tissue and pectoral fascia, en masse. If the growth definitely involves the fascia, as evidenced by immovability of mass and fixation to pectoralis major beneath, the pectoral muscles are sacrificed, along with the fascia covering the upper portion of the rectus.

I have not found it necessary to routinely sacrifice the pectoralis muscles, nor have I cared to remove them, as I think it pretty definitely proved that dissemination takes place through the fascial covering of the muscles. I have never seen the muscles involved by cancer, except by direct extension. There are those who claim to have found the muscle involved. I believe the fascia is the structure that is involved primarily, and then the muscle secondarily, by continuity.

Moreover, I feel quite certain that with my plan of irradiation all cancer cells will be destroyed by the radium. The presence of the muscle, I feel, is of some advantage, though not absolutely essential as a protection to the ribs where radium is so used. I think it well to meticulously clean the muscles of fascia, or remove them if involved, and then rely upon the radium to care for such cancer cells as may be beyond the reach of the scalpel.

The operation completed and all bleeding carefully controlled, radium is placed, as shown in the diagrams, keeping in mind the location of the lymph nodes, as shown in Figure 1. Figure 2 shows a rubber tube containing 25 mg. of radium element, screened by silver, brass and rubber. I have left the radium in position from six to ten hours.

Points $1\frac{1}{2}$ in. apart are marked with silk ligature, so that the radium may be withdrawn a definite distance each six or ten hours, thus insuring careful and thorough irradiation.

It has been found that radium acts effectively for from 3 to 4 cm. through the tissues. Ten-milligram needles are placed in the intercostal spaces next to the sternum and about the middle of the intercostal muscles, and left there for from twelve to twenty-four hours. These needles definitely irradiate the internal mammary lymph glands.

One or two 10 mg. needles are placed in the supraclavicular space on the side involved.

A second rubber tube containing 25 mg. of radium, is placed beneath the clavicle, so that as it is drawn downward, as before described, the whole chest wall and the skin over the wound may be well irradiated. If the radium is left in each position for from six to ten hours, it will cause an

erythema of the skin which later becomes brown. This latter sign is a good index that the area has been thoroughly irradiated.

CONCLUSIONS

This paper presents a plan of radium irradiation, to be used at the time of and in conjunction with surgery in the treatment of operable carcinoma of the breast.

I believe that radium, when employed as outlined, in conjunction with surgery, is far more efficacious in dealing with cancer of the breast than is the scalpel alone.

Unfortunate victims of breast cancer should, in addition to a thorough operation, be given the advantage of carefully planned radium irradiation at the time of the operation, and by such a technique as herein advocated.

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LEAD-ANTIMONY AMPULES CONTAINING RADON FOR IMPLANTATION IN CANCER*

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CHICAGO, ILL.

TWO types of tubes containing radium or radon are in common use for implantation in cancer, the removable and the permanent. Removable tubes, usually in the form of steel or platinum needles containing one or more milligrams of radium sulphate, have several objectional features, among which are the following.

It is difficult to determine the duration of time that removable needles should be left in cancer in order to sterilize a given field. If a single viable cancer cell is left, recurrence may take place.

It is often an ordeal for the patient to tolerate removable needles in the tongue or other tissues for a number of hours, as customary with this method.

It is possible that infection, traumatism and consequent metastasis are favored by the presence of the silk or linen threads attached to removable needles.

For these and other reasons, removable tubes or needles have been largely replaced in this country by very minute tubes or ampules containing radon, which are buried by means of a fine trocar and left permanently in the tumor. These ampules may of course slough out during the healing process; often they remain permanently encysted in the tissues.

In the treatment of selected cases of carcinoma, the implantation of radon ampules made of glass has been in vogue approximately since 1917 although continued experience has shown some objectional features to their use. For example, a good deal of pain is sometimes caused by glass ampules and there may be an unnecessary amount of tissue necrosis. Hemorrhage, sometimes alarming in character, occasionally occurs during the separation of the slough.

To do away with these objections, gold ampules were ingeniously devised by Failla¹ in 1926. The primary object of gold ampules was, of course, the reduction of the transmitted beta radiation, which in the case of glass is practically 100 per cent, so as to minimize the amount of tissue reaction and necrosis.

Experiments have demonstrated that the volume of tissue necrosis following the implantation of gold ampules with a wall thickness of 0.3 mm., and a content of 2 mc., is reduced to approximately one-fifth of that caused when glass ampules containing 1 mc. are used.²

Experience has shown, however, that in some cases pain, persisting almost indefinitely, has been set up by the use of permanently buried gold ampules, particularly in cancer of the tongue. This feature is an almost insuperable objection to the use of gold.

Casting about for other materials, we were led to devise ampules made of capillary lead tubing. From surgical experience with ordinary "lead bullets," we believed that lead would be well tolerated by the tissues. Recently, on account of the difficulty of obtaining capillary lead tubing with a constant bore and wall thickness, we have used a lead-antimony tubing, the latter metal in the proportion of 5 per cent. Being slightly harder than pure lead, lead-antimony tubing is more easily manufactured and handled.

The internal diameter of the lead antimony tubing is 0.15 mm., the wall thickness being 0.3 mm. Each ampule is from 2 to 3 mm. long and contains from 0.5 to 1 mc. of radon, the strength varying somewhat in different cases.

We have now a small group of cases in which recovery has taken place and the

* Submitted for publication April 13, 1931.

ampules have become encysted in the tissues without giving rise to persistent pain or other undesirable symptoms.

Based on data obtained by Quimby,³ who carried out some experiments with gold, a comparison of radiation absorbed by gold and lead respectively may be made.

Gold ampules with a wall thickness of 0.2 mm. will absorb slightly more than 99 per cent, while lead ampules with the same wall thickness will absorb 97.4 per cent of the primary beta radiation.

In all probability, 5 per cent lead-antimony ampules do not differ materially from pure lead in the amount of beta rays which they absorb. We believe the slightly greater portion of beta rays transmitted by lead or lead-antimony is not undesirable, as the hard beta rays mixed with gamma rays are approximately eight times as lethal to the cancer cell as gamma rays alone.⁴

The implantation method should be limited to carefully selected cases. In our hands the implantation of ampules in carcinoma is practically always preceded by the application of approximately 1000 mc. to the surface of the tumor.

We believe the development of lead-antimony ampules is a distinct advance in the therapy of inoperable cancer, especially when it involves the tongue, buccal mucous membrane, rectum, etc.

In the use of gold or lead-antimony ampules, a word of caution may be given. It may not be generally known that metal ampules of this type are not sealed by annealing as in the case of glass but by a special forceps which cuts and seals the ends of each ampule by mechanical pressure. In effect, a cold weld of the gold or lead-antimony is formed. Sometimes, in spite of the greatest care and skill, the weld is not perfect and a slow or fast leak develops.

Unless ampules of this type are carefully tested individually with the electroscope several times in the twenty-four hours prior to their use, there is no certainty that they contain the specified amount of radon or, indeed, any radon at all.

It is possible that failures to achieve certain results in cancer may be traced to leaks, which may easily escape detection when facilities for measuring are not at hand.

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LIMITATIONS OF THE HISTOLOGICAL GRADING OF TUMORS*

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CONTRARY to what one might suppose from a survey of recent tumor literature, the histologic grading of tumor malignancy is nothing new, nor did it originate in American pathology. As a matter of fact, tumor grading is almost as old as modern cellular pathology, for Virchow himself recognized grades of malignancy and actually employed the expression "Skala der Bösartigkeit" or "Scale of Malignancy." Tumor grades were recognized by von Rindfleisch, Borst, Schottländer, Bard, Fränkl, and others. In fact every pathologist who has dealt much in the tumor field has mentally or by elaborate description divided tumors into various grades of malignancy. Nevertheless the grading of tumors has become greatly popularized of late, largely by the substitution of figures for complicated descriptions which meant much to the pathologist and little to the clinician, and by many statistical studies which revealed the importance of tumor grades for *group* prognosis.

It is well to emphasize the expression "group prognosis." In most varieties of malignant tumors the pathologist can, from the sections alone, divide the tumors into rough subdivisions of grades I, II, and III, or perhaps more, depending somewhat on his self-assurance, and find a fair correlation between ascending tumor grade and ascending malignancy, as judged by duration of symptoms prior to therapeutic interference,¹ therapeutic success, duration of life, and extent of metastases. But what applies to a group of patients may not concern at all the individual patient and the problem of the pathologist is to endeavor to make, by using all means at his disposal, some worthwhile prognosis for the case in question.

In the individual patient, the extent of disease and the accessibility of the lesion outweigh all other considerations and the pathologist who, through clinical consultation, is able to familiarize himself with these factors as well as with the histology of the tumor in question should be able to make a far more accurate prognosis than can either the clinician or the pathologist alone. For example, with metastases to the high axilla in breast cancer or to the cervical nodes in intraoral cancer it seems to make little difference to the patient what the histologic grade is in the primary tumor, but it might make considerable difference in two tumors of the same size approximately and the same location, assuming one were a grade I and the other a grade III, and assuming likewise that in neither were the nodes clinically involved. In the former grade it might be quite justifiable to attack the local tumor aggressively and leave alone the node area, whereas in the latter the presumption is so strong that the node area is involved, though not clinically evident, that an aggressive attack on the drainage area is usually indicated.

Next to extent of disease and accessibility of lesion the fundamental tumor type is of great importance for there are groups of tumors which are almost invariably fatal no matter when they are first discovered or how accessible they are, for example the lymphosarcomas and most of the melanomas. In the latter group location seems to be of considerable importance, since the long survivals are as a rule the ocular and the subungual types although there is nothing in the histology or grading of these varieties which would make one suspect them to be of a more favorable prognosis as regards

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length of life. Fundamental tumor type is of great importance in another neoplastic disease, neurogenic sarcoma; these tumors are usually diagnosed as fibrosarcoma by the pathologist. They comprise most of the soft part sarcomas. Yet they are not fibrosarcomas in the ordinary sense but are really nerve tumors, Schwannomas, derived from the sheath of Schwann. They are a localized manifestation of von Recklinghausen's disease and although they may not look very malignant they exhibit an almost uniform tendency to recurrences, the latter not being recurrences in the true sense but new tumors developing in nerves of the same territory. It is often considered a relatively benign disease yet actually constitutes one of the worst diseases one has to deal with. Assuming that the local tumor may not recur there may be a tendency toward the development of new tumors all the way up the nerve trunk from its termination to the spinal cord. The microscope does not tell us this, but a knowledge of the fundamental nature of the tumor and its clinical course does. Examples of this sort might be multiplied almost indefinitely.

Location of disease is important since the prognosis assigned to a similar histologic grade varies greatly with the site of the tumor. For example an adenoma malignum of the rectum may closely resemble an adenoma malignum of the stomach yet it is quite different in prognosis. When adenoma malignum of the rectum penetrates the muscle coat it often spreads slowly out into the pelvic fat, whereas adenoma malignum of the stomach once outside of the organ finds a diffuse peritoneal surface to implant itself upon. In estimating prognosis then the pathologist should be able to say "This is a low grade adenoma malignum of the rectum. The tumor has slightly invaded the fat just beyond the serosa but infiltration is limited; the prognosis is fair." Under the same circumstances he would be forced to say "This is a low grade adenoma malignum of the stomach. It has reached

the peritoneal surface. The probability is that tumor cells are already widely implanted. The prognosis is very bad." Going to another location, the intraoral cavity, two histologically identical sections are presented for opinion. One is from a tumor of the lateral border of the tongue anterior, the other from the pyriform sinus. In neither are nodes involved by clinical examination. The prognosis of the first is fair assuming the tumor to be a grade II. In the latter location it is bad. The location is inaccessible; infection is difficult to control; hemorrhage cannot be successfully cared for by ligation in the majority of instances and inhalation pneumonia is common. Yet the tumors may be of the same appearance microscopically and of the same size and extent clinically. The influence of radiosensitivity on prognosis cannot be adequately considered at this time.

Prognosis is greatly influenced by the condition under which the tumor arises. Again reference may be made to the rectal group. A fair number of the malignant adenomas of the rectum originate as rectal polyps. Rectal polyposis is often part of a generalized polyposis of the large bowel. Whereas the prognosis of a solitary rectal adenoma malignum might be rather good depending on its local status, the outcome of the disease might be entirely different since several polyps in a multiple polyposis might become malignant either simultaneously or successively and the grade of malignancy for one might vary from the next. This applies very much to a certain group of tumors falling in the genitourinary field, namely the papillomas of the bladder. The registry of bladder tumors grades the bladder papilloma as a benign lesion and quite correctly so. However, some bladders contain numerous papillomas, or show a diffuse papillomatosis which greatly alters the prognosis of the disease. Certain bladders show a tendency to recurring polyps in different locations over a long period. The microscope tells one that a papilloma is benign but does not tell one

that there is a diffuse papillomatosis or that there is a tendency for multiple papillomas developing successively over a period of time and therefore eliminates the most important method of estimating outcome of the disease. Neither does it tell one that the papilloma has blocked the ureteral orifices, is infected, and that ascending urinary infection is present. In fact the slide leaves out all the important factors necessary for complete understanding of the case.

The same microscopic criteria cannot be used for grading histologically similar tumors in different locations, as previous examples have shown us. An infiltrating squamous carcinoma of the lip with fairly well developed pearls may be grade II, while in the bladder it is grade III, since the low grades in the bladder apply to the papillary growths, and not to the infiltrating squamous varieties. The latter are usually the flat, non-papillary, infiltrating ulcers. This brings us to another important factor in tumor grading, namely that of anatomical type. We have been told that tumor grading should be based on the fundamental concept of cell anaplasia. Nothing is more erroneous, for various tumors whose cells exhibit marked anaplasia, are of such anatomical types that they belong in low grade varieties. If one grades on the basis of anaplasia, then one must grade according to the degree of anaplasia within the certain anatomical tumor type. The breast group is an excellent example. We have within the breast certain tumors which develop within cysts or dilated ducts. They grow often rapidly to large size and ulcerate the skin. They are often extremely cellular and anaplastic and yet they are slow to involve lymph nodes. Although anaplastic they should constitute the grade I of breast cancer. Their comparative prognosis with the infiltrating duct carcinoma of the breast is similar to the comparative prognosis of cellular papillary bladder carcinoma to the infiltrating squamous type.

There are certain local conditions within an individual tumor which alter prognosis and which section will fail to bring out. A rectal tumor of low grade may accidentally

invade a vein. The case reported by Dr. McNattin was not a highly malignant tumor, but a renal tubule carcinoma not very cellular and very calcific. Yet it had accidentally invaded the renal vein and metastasized and its metastatic cells under different physiological, nutritional circumstances had become extremely anaplastic and malignant. The metastatic cells had survived and multiplied in very unusual locations, for example the cardiac muscle and the tongue.

Lastly, physiological status and unexplained local inflammatory conditions may alter prognosis. Breast carcinoma developing during lactation or pregnancy has an almost uniformly rapid course and fatal prognosis. The same is true of breast cancer developing in an inflammatory setting: the acute inflammatory carcinosis of the breast. Delbet saw one such patient die within six weeks of the onset of disease. Inflammatory carcinomas and carcinomas of lactation or pregnancy may not look worse under the microscope than do other carcinomas, and yet they are distinct clinical entities.

CONCLUSION

1. Any prognosis based upon the purely histological grading of tumors should apply to a group rather than to an individual.
2. If prognosis is to be ascertained with any degree of accuracy for an individual it must be based upon
 - (a) Gross tumor anatomy and fundamental tumor type
 - (b) Histology
 - (c) Location, extent and accessibility; solitary or multiple setting; nature of tumor bed
 - (d) General and special physiological status of the individual
 - (e) Radiosensitivity of the tumor.
3. In the absence of all the ascertainable facts about an individual patient, no reasonably accurate prognosis is possible.
4. Individual prognosis should be based on clinical-pathological consultation whenever practical, rather than on the clinical examination or the microscope alone.

THE PATHOLOGY AND TREATMENT OF MALIGNANT NEOPLASMS OF THE TESTICLE*

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MALIGNANT testicular neoplasms are rare. Their incidence is 50 cases in 300,000 admissions to the Mayo Clinic, Rochester, Minn., or 1 case in 6000, in a material for the most part ambulatory and chronic (Tanner).

The pathological museum of the Sydenham Hospital, New York, has 8 specimens. This represents the material of 9511 admissions to the hospital in the thirty months up to June 24, 1929, and is about five times its quota.

These tumors are so rare that few surgeons have an experience of more than a few patients, upon whom they have personally operated. Most of the studies in the literature are those of workers who have had the benefit of the records of large institutions.

Among these are the studies of:

	Cases
Chevassu	112
Tanner	101
Cairns	93
Nicholson	65
Howard	65
Dew	39
Hinman	30 (Johns Hopkins Hospital)
Geist and Thalhimer	26
Hinman et al	22 (University of California cases)
Ewing	19
Schultz and Eisendrath	14
O'Crowley and Martland	13
Dean	6

PATHOLOGY

Out of the maze of faulty observation and misinterpretation, Chevassu in 1906 in a study of 128 tumors, not all malignant, mostly from the Paris clinics, some of which he observed clinically, others which

he studied merely from museum specimens, gave a classification which is considered by some to have stood the test.

CHEVASSU'S CLASSIFICATION OF 128 TESTICULAR TUMORS

	CASE
Epitheliome seminal	59 1- 59
Tumeur des cellules interstitielles	1 60
Adenome testiculaire	3 61- 63
Fibrome	1 64
Sarcome	1 65
Embryome	62 66-127
Tumeur secondaire	1 128
Of the 62 Embryomes:	
Teratomes	7 66- 72
Tumeurs mixtes non degenerées micr	5 73- 77
Tumeurs mixtes degenerées	50 78-127
Of 50 Tumeurs mixtes degenerées:	
Degenerescence sarcomateuse	5 78- 82
Degen.—Type epithelioma infiltre (adeno carcinoma)	17 83- 99
Degen.—Type epithelioma papillaire (papillary carcinoma)	15 100-114
Degen.—Type placentaire (chorio-epithelioma)	13 115-127

Briefly, his views were that the majority of malignant testicular tumors were either *degenerated embryomata* (the so-called mixed or teratoid tumors of other writers), or *seminomata* (a solid tumor derived in his opinion from the epithelium of the seminiferous tubule). He held that the latter are not teratoid and that he could find no relation between the two groups, which form 121 of the 128 testicular tumors embraced in his study. His classification is really a list in which these types predominate numerically.

In 1911, Ewing followed with a study, and later in his work on Neoplastic Diseases gave the following classification:

Teratomata testis are divided into:

- I. Adult embryomata or teratomata
- II. Embryoid, teratoid or mixed tumors
- III. Embryonal malignant tumors

* From the Pathological Laboratory of Sydenham Hospital, Dr. A. A. Eisenberg, Director.
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This is based on an idea originated by him and concurred in by others, particularly Hinman, that the epithelioma seminal

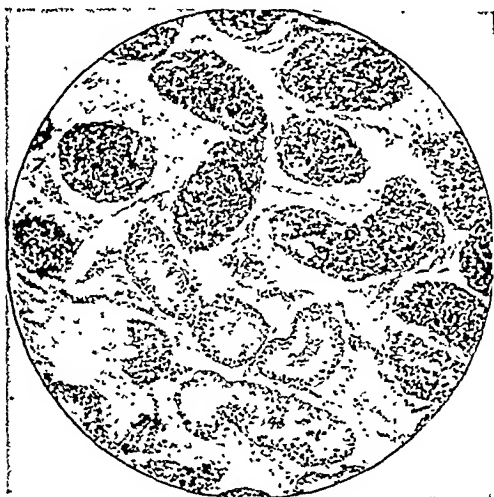


FIG. 1. Dew's Case 31, showing development of carcinoma in seminiferous tubules.

or seminoma of Chevassu, is not a tumor separate and distinct from the malignant embryoma, but that it is an embryoma or teratoid tumor, in which there is a one-sided cellular development, resulting in a homologous-celled tumor with lymphoid stroma. His view is that this large (spheroidal) type of epithelial cell overgrew the other cells in the development of the embryoma in an organ, the epithelial structures of which contain totipotent cells in large numbers.

This theory is attractive but thought by some to be unproved, and has caused the observers to divide into two groups.

Ewing says in discussing Case 9 of his series of 19 specimens, which case was a typical "seminoma" with marked necrosis, in which no trace of columnar or flat epithelium, cartilage or muscle could be found: "The conclusion that the tumor is a one-sided development of a teratoma is based on the fact that its highly peculiar structure is exactly duplicated in other tumors of this series in which tridermal elements were demonstrated." This is not an entirely convincing argument, as there is no reason why embryomata cannot

develop areas identical with "seminomata" from seminal cells, as this type of origin is not disproved and is the point under discussion. Also half of the malignant testicular tumors are histologically pure "seminomata" in which other elements are practically never found.

A good argument in favor of Ewing's theory would be the finding of elements from two or more germ layers in specimens that were apparently "seminomata," by serial sections of such tumors. Dew tried to substantiate this and failed. Hinman succeeded in one of his seminomata. He states that Ewing was able in several instances to demonstrate seminomatous tissue in teratomata (embryomata), and tissue of other germ layers in seminomata.

While the cell of the seminoma has a strong resemblance to the cell of the normal seminiferous tubule, the strongest morphological evidence would be the finding in an early tumor of areas in which the normal seminiferous tubule shows the development of tumor cells. Dew shows a specimen (Case 31) with a tumor starting in the lower pole of the testicle, in which the section seems to show definitely that the spheroidal cell carcinoma (seminoma) starts in some of the adult seminiferous tubules.

Schultz and Eisendrath agree with Chevassu, claiming that the seminomata are derived from seminal epithelium. They offer the term spermatocytomata to replace seminoma. Unfortunately they use the term embryonal carcinoma for embryoma, which further complicates the nomenclature, as Ewing introduced this term in 1911 to designate the tumors called seminoma by Chevassu and to indicate that they were carcinomata of an embryonal type and not imitative of any glandular structure.

A better term than any is that used by Dew, spheroidal cell carcinoma, as it does not attempt to indicate the origin of the tumor, which point is under discussion.

The classification of Schultz and Eisendrath however has excellent features.

Classification of Schultz and Eisendrath —1921

I. Homologous Tumors

A. Benign seminiferous tubules Epithelial (adenoma of Chevassu and Pick)

B. Malignant

Spermatocytoma (the seminoma of Chevassu; the embryonal carcinoma of Ewing)

II. Heterologous Tumors

A. Benign

Adult teratoid tumors or cystic dermoids

B. Malignant

1. Embryonal carcinoma (embryone of Chevassu)

Heterologous tissue may be present or may have been overgrown. The typical tissue may be:

a. Trophoblastic (chorioepithelioma)

b. Hypoblastic (the usual adenomatous tumor)

c. Epiblastic (solid alveoli of basal cell type or tumors of neurocytoma type)

2. Sarcomatous mixed tumors very rare as a pure tumor; probably the few authentic cases of sarcoma reported as heterologous tumors represent one-sided development of teratomata.

Hinman et al. prefer to modify Schultz and Eisendrath's classification. They accept their idea of calling embryomata, embryonal carcinoma, but place the seminoma under this heading, as being of mesoblastic origin, which they themselves realize is unproved. Their classification is:

I. Homologous Tumors

A. Benign

1. Epithelial

a. Adenoma of the seminal tubules (the tumors of Chevassu and Pick are accepted by Ewing)

2. Mesoblastic

a. Interstitial cell tumors (probably not true tumors, but merely hyperplasia-Ewing)

b. Malignant (do not occur)

II. Heterologous (teratomata or mixed tumors)

A. Benign

1. Adult teratoid tumors or cystic dermoids (exceedingly rare)

B. Malignant (embraces practically all tumors of the testicle)

1. Embryonal carcinoma (heterologous tissues may be present or may have been overgrown)

a. Trophoblastic (chorioepithelioma)—rare

b. Hypoblastic (the usual adenomatous tumor)

c. Epiblastic (solid alveoli of basal cell type or tumors of neurocytoma type)

d. Mesoblastic (?) (so-called seminoma—they constitute about one-half of the malignant tumors occurring in the testicle)

2. Sarcomatous mixed tumor (true sarcoma occurring in teratoma is very rare; probably the few authentic cases of sarcoma reported as homologous tumors represent one-sided developments of teratomata.

For a working classification, the best and simplest is that of Tanner:

A. Malignant

1. Carcinomatous large cell large nucleus type undoubtedly closely related to the mixed type

2. Mixed type

a. Tumors containing cartilage, cysts, glands, etc.

- b. Ordinary glandular structure tumors
- c. Chorioepithelioma

B. Benign

- 1. Dermoid
- 2. Epithelial
 - a. Adenoma of the seminal tubules as described by Chevassu and Pick
- 3. Mesoblastic
 - a. Interstitial cell tumors
 - b. Fibroma
 - c. Lipoma, myxoma, etc.

In his classification, carcinoma is the seminoma of Chevassu, or the spheroidal cell carcinoma of Dew and other English writers. We shall in this article use the latter term from now on.

Tanner's classification has under mixed type a subheading, a, tumors containing cartilage, glands, etc. This mixed tumor is the malignant embryoma; we shall use this term from now on.

Such a classification is not only practical, but it takes sides with Dew's conception of the probable histogenesis of these tumors from the totipotent cell:

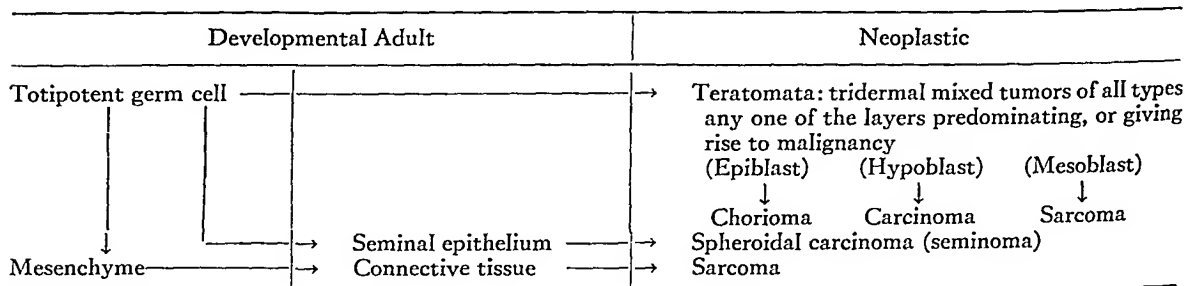
deciding whether or not to proceed upon the radical operation after preliminary orchidectomy has been done.

PATHOLOGICAL HISTOLOGY

From a histological standpoint the two types of malignant tumors, which embrace nearly all of the testicular tumors are firstly, the spheroidal cell carcinomata of the homologous tumors, and secondly, the malignant embryomata of the heterologous tumors.

This attitude seems more advantageous at present, until further studies and discoveries have rendered more certain the theory of the unity of their pathogenesis.

The carcinomata are composed of one type of cell, a large cell, usually spheroidal or ovoid in shape, pale and transparent. At times there is a cobweb appearance due to the fine tendrils which extend from the periphery of the cell body to other cells. The nucleus is compact and stains deeply. The carcinoma cells are supported by a delicate framework of fibrous tendrils, which hold in their meshes very tiny deeply staining cells, that look like small



This idea sides with Chevassu, which seems more probable from a morphological standpoint, until thoroughly refuted by other methods of investigation.

The morbid anatomy of malignant neoplasms of the testicle will be described under the Procedure of the Radical Operation. It was arranged in this manner because from a practical standpoint it is necessary for the surgeon to have a good knowledge of the gross appearances of the cut section of these tumors in order to use this in conjunction with other data in

lymphoid cells. This framework with its lymphoid stroma varies in amount in different specimens, although it is never abundant enough to give the tumor a fibroid texture. There is no true alveolar formation, but there is a tendency in some specimens toward this as described by Geist and Thalhimer and used by them in attempting to differentiate various histologic types. Carcinomata are for practical purposes histologically homologous, although some observers claim to have found by serial sections tissue of other germ layers.

Carcinoma resembles the granulomatous type of testicular syphilis very much, especially when the lymphoid stroma is not in great evidence. This makes the differentiation very difficult, as grossly such tumors have a cut surface that looks similar, and unless the frozen section is very excellent, the microscopist is at a great disadvantage.

The embryomata are histologically heterologous or mixed tumors. Histologically all three of the germ layers may be represented although most commonly mesoblast and hypoblast are found. They usually present hypoblastic glands lined with columnar epithelium, some of which may contain goblet cells, such as are found in the gastrointestinal tract. Other cysts are found lined with cuboidal and columnar epithelium. There are myxomatous areas, although most of the supporting framework is of firmer fibrous tissue. In some are to be found areas of cartilage, neuroepithelium and cysts filled with colloid material taking the eosin stain and somewhat resembling thyroid alveoli.

Up to this point in the description, the embryoma does not appear histologically very malignant, although cases have been reported in which there have been metastases from such tumors containing even cartilage. Such a case was reported by Paget. However, as a rule, these tumors show a tendency at some time or other to degenerate in some of their areas into papillary or into adenocarcinoma. These are the ones in which metastasis is a danger. These degenerated areas occur only in certain parts of the mixed tumor, the tumor requiring therefore numerous blocks from various parts in order that this be not overlooked. Other portions not far removed show only the mixed tumor just described.

We have seen both of these types of degeneration in our series. We have not encountered any areas in our mixed tumors, that resemble the spheroidal cell carcinomata, although the specimens have not been serially sectioned.

A word must be said about the pathological anatomy and histology of the syphilitic testicular tumor. Some of these



FIG. 2. Similar development in 1 of our cases, Path. No. 2343. Note similarity of carcinoma cells to cells of normal seminiferous tubules in neighborhood of tumor cells.

show nodules with geographical or circinate margins (gummata). Others are merely homogeneous tissue very like the carcinomata. Histologically two types are found. In the former there is a great deal of fibrosis enclosing only nests of round cells. In the latter, the homogeneous or granulomatous type, the tissue resembles granulation tissue and has many capillaries supporting a tissue composed almost entirely of moderately sized mononuclear cells; it is this type that resembles histologically the spheroidal cell carcinoma, when this tumor has little or no lymphoid stroma. We present two specimens which represent one of each type.

Our photomicrographs will show representative areas of each type of malignant tumor, as well as some of the representative types of tissue found in embryomata,

including the varieties of carcinomatous degeneration. Microscopic areas of syphilitic testicles will be shown for comparison.

Painful mass of six weeks' duration in right side of scrotum.

Physical Examination: Right side of scrotum

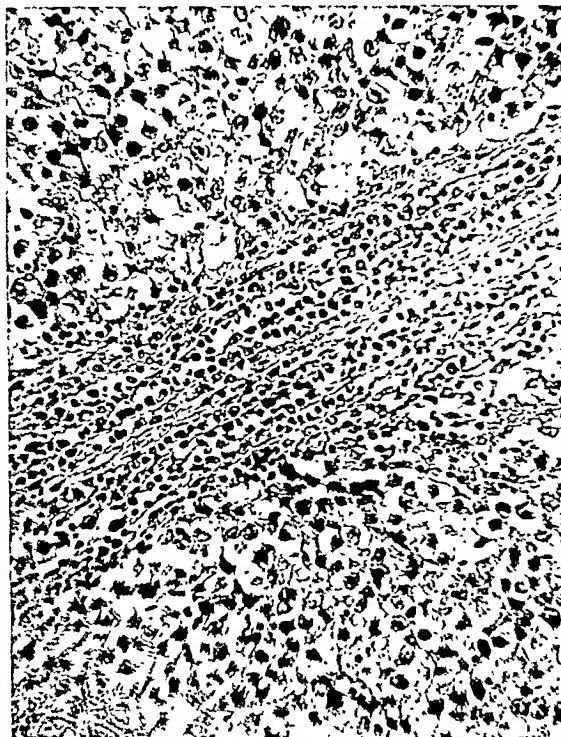


FIG. 3. Pathological No. 1884. Spheroidal cell carcinoma with typical lymphoid stroma.

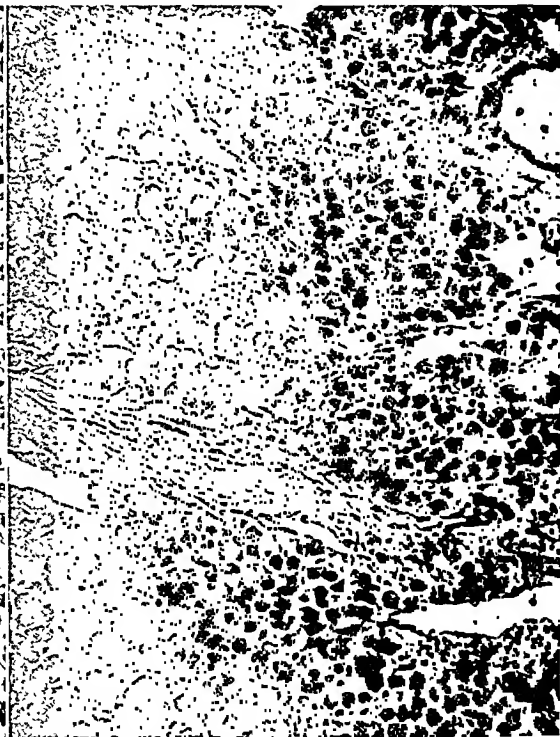


FIG. 4. Pathological No. 2904. Spheroidal cell carcinoma showing paucity of lymphoid stroma. This type although more cellular resembles granulomatous type of syphilis.

CASE REPORTS

Abstracts of the histories of cases in the Sydenham Hospital series are here given.

They consist of 5 cases of spheroidal cell carcinoma; 3 cases of malignant embryoma; and also the histories of 2 cases of syphilitic testicular tumor are given.

It will be noted that there is a slight discrepancy in some cases in the nomenclature of Pathological Diagnosis found on the chart, as compared with that of the Revised Diagnosis, which latter refers to the study of the author.

ABSTRACTS OF CASE HISTORIES FROM SYDENHAM HOSPITAL RECORDS

CASE I. History No. 4941; Pathological Laboratory No. 1315.

P. G. Aged thirty; Admitted June 5, 1928; discharged June 10, 1928.

contains a hard painful mass involving the epididymis; skin of scrotum reddened. No abdominal masses felt.

Provisional Diagnosis: tuberculous epididymitis.

Operation: June 5, 1928, orchidectomy.

Pathological Diagnosis: teratomatous adenocarcinoma.

Gross Pathology: The tissue is solid in one portion; in another portion it is filled with cystic areas.

Microscopical Pathology: The tissue is distinctly papillary adenocarcinoma; there are also acini lined with a single layer of columnar epithelium of endodermal origin.

Revised Diagnosis: Embryoma (with papillary adenocarcinomatous degeneration).

After Course: July 18, 1929. Admitted to Bellevue Hospital for pulmonary tuberculosis.

CASE II. History No. 9511; Pathological Laboratory No. 2904.

Anthony B. Aged thirty-two; Admitted June 24, 1929; discharged July 6, 1929. Swelling of the right testicle for one year;

Aron P. Aged fifty-seven; Admitted Nov. 15, 1928; discharged Dec. 2, 1928. Right hernia fifteen years ago; left-sided



FIG. 5. Pathological No. 1315-2. Malignant embryoma showing a gland of hypoblastic type lined with columnar epithelium, lying in myxomatous matrix.



FIG. 6. Pathological No. 2023. Malignant embryoma showing intestinal type of gland with goblet cells.

occurred after trauma; gradual increase.

Physical Examination: Mass in right side of scrotum, size of a man's fist.

Provisional Diagnosis: Tumor of the right testicle.

Operation: June 26, 1929, orchidectomy.

Pathological Diagnosis: seminoma (embryonal carcinoma).

Gross Pathology: Shaped like a testicle and about five times as large; on section it shows grossly some small cystic area but the tissue is for the most part solid, greyish, divided by trabeculae into lobules; tunica vaginalis is not involved; epididymis shows caseous (?) cavities.

Microscopical Pathology: Typical seminoma with marked fibrous trabeculae; not much lymphoid stroma. Veins of the cord are not involved.

Revised Diagnosis: Seminoma (same as preceding).

CASE III. History No. 6825; Pathological Laboratory No. 1884.

cryptorchism.

Four months ago the left cryptorchid became swollen and painful.

Physical Examination: Mass present in left inguinal region, size of an egg; movable, and not very tender.

Provisional Diagnosis: Not noted.

Operation: Nov. 16, 1928. Left-sided orchidectomy.

Pathological Diagnosis: Embryonic sarcoma of the testicle.

Gross Pathology: Mass shape of and twice the size of a testicle; tunica not involved; solid on section, smooth, no cysts, some necrotic spots, some lobules.

Microscopical Pathology: Seminoma, with typical lymphoid stroma.

Revised Diagnosis: Seminoma.

CASE IV. History No. 7944; Pathological Laboratory No. 2343.

Herman G. Aged sixty-two; Admitted Feb. 25, 1929; discharged March 10, 1929.

Trauma to right thigh three months ago; several days later right testicle swelled; a hydrocele was tapped several times.

Physical Examination. Right side of scrotum contains a mass $2\frac{1}{2} \times 2 \times 1$ in. Firm, not tender; skin movable; both testis and epi-

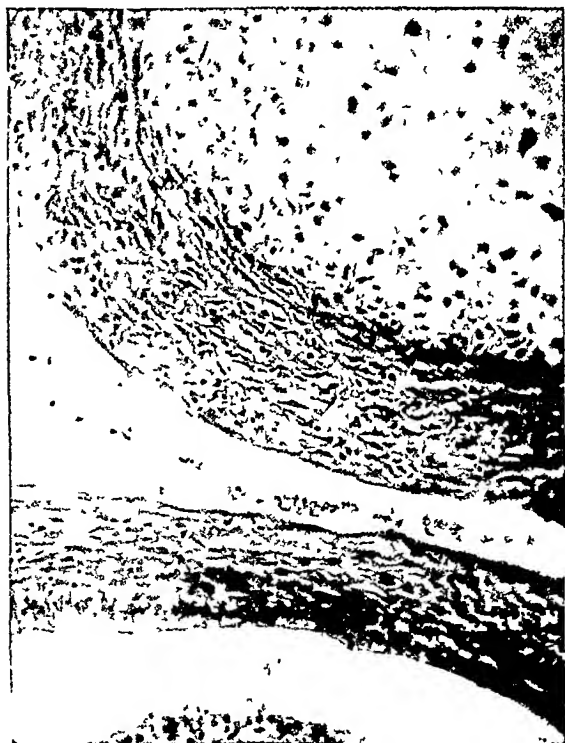


FIG. 7. Pathological No. 166-1. Malignant embryo. An area showing simple gland adjacent to area of cartilage.



FIG. 8. Pathological No. 166-4 Malignant embryo. An area showing gorter-like alveoli.

Physical Examination: Right testicle size of a tangerine, tense fluctuant; transmits light; abdomen negative.

Provisional Diagnosis: Internal hydrocele.

Operation: Feb. 27, 1929. Right orchidectomy.

Pathological Diagnosis: Reticulum cell sarcoma.

Gross Pathology: On section the tumor looks like marble; the epididymis shows caseous (?) areas.

Microscopical Pathology: It is mostly fibrous tissue enclosing areas of cobweb cells with large areas of early degeneration; no lymphoid stroma seen.

Revised Diagnosis: Seminoma.

CASE V. History No. 2637; Pathological Laboratory No. 589.

Ralph S. Aged twenty-nine; admitted Nov. 4, 1927; discharged Nov. 16, 1927. Right testicle began to enlarge two years ago; Wassermann test negative.

didymis seem involved. Cord normal.

Operation: Nov. 4, 1927. Castration, local anesthesia.

Pathological Diagnosis: Large round celled sarcoma.

Gross Pathology: Tunica not involved; on section it is composed of small cavities filled with cobweb like tissue; the walls of the cavities are supported by fibrous trabeculae. In one area there seems to be normal or compressed testicle. Grossly the tumor resembles embryoma on account of the cavities.

Microscopical Pathology: The tumor is composed of embryonal carcinomatous cells spheroidal in shape with lymphoid stroma.

Revised Diagnosis: Seminoma.

CASE VI. History No. 729; Pathological Laboratory No. 166.

Harry W., admitted April 21, 1927; discharged May, 6, 1927. Swelling of the right testicle four months ago; aspirated but no fluid obtained.

Operation: April 22, 1927. Right orchidectomy.

Pathological Diagnosis: Malignant teratoma with adenocarcinoma.

Pathological Diagnosis: Malignant teratoma.

Gross Pathology: Solid tumor of rather glairy tissue; shaped like a testicle; some



FIG. 9. Pathological No. 166-2. Malignant embryoma. An area showing neuroepithelial rosettes.

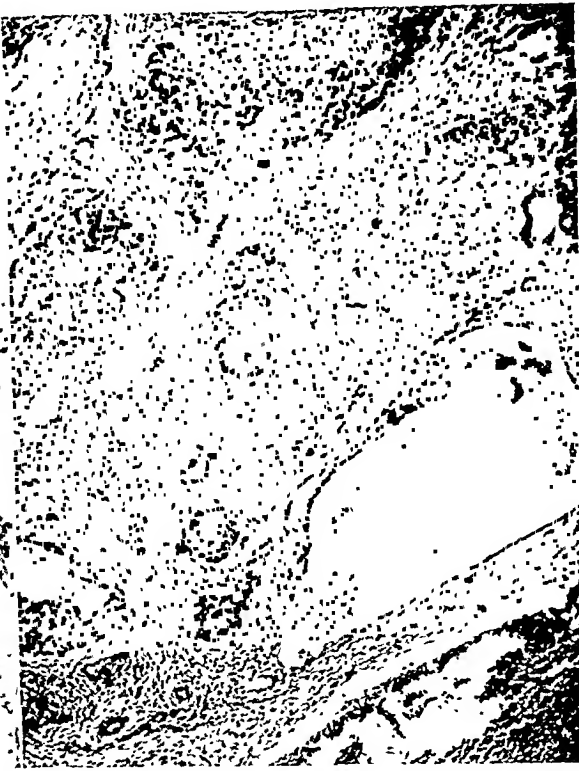


FIG. 10. Pathological No. 166-3. Malignant embryoma. An area showing adenocarcinomatous degeneration.

Gross Pathology: Tunica not involved; on section there are many cysts; the epididymis is hemorrhagic.

Microscopical Pathology: There are cystic alveoli lined with columnar epithelium; myxoma; cartilage; "rosettes of neuroepithelium"; adenocarcinomatous areas; no seminoma is present.

Revised Diagnosis: Embryoma with adenocarcinomatous degeneration.

CASE VII. History No. 7119; Pathological Laboratory No. 2023.

Alexander P. Aged thirty-one; admitted Dec. 13, 1928; discharged Dec. 21, 1928. Mass began to form in right side of scrotum three months ago; tapped twice but only blood stained fluid obtained. Is increasing in size but is not tender.

Physical Examination: In right side of scrotum is an orange sized mass, heavy, hard, firm, smooth; skin movable; does not transmit light.

Operation: Dec. 14, 1928, orchidectomy.

cystic areas; some meaty and some fatty looking areas.

Microscopical Pathology: Tissue resembling myxoma or myxosarcoma with glandular elements lined with columnar epithelium, probably of hypoblastic origin.

Revised Diagnosis: Embryoma.

Course: In Montefiore Home Jan. 9, 1929.

CASE VIII. History No. 8475; Pathological Laboratory No. 2489.

Jas. E. Age thirty-six; admission April 8, 1929; discharged April 15, 1929. Noticed that left testicle was enlarging one and one-half years ago.

Physical Examination: Left testicle size of a fist, hard and painful on pressure.

Operation: April 8, 1929, orchidectomy.

Pathological Diagnosis: Seminoma.

Gross Pathology: Tumor the shape of and about three times the size of a testicle. On section the tissue is pale and homogeneous and contains little nodules. No cysts; testis not identified; epididymis not involved.

Pathological Histology: Pale spheroidal cells with lymphoid stroma; much mitosis; much degeneration. The epididymis shows areas of

Pathological Histology: Very little fibrosis; in general the testis is replaced by granulo-matous tissue with thin walled capillaries and



FIG. 11. Pathological No. 1315-1. Malignant embryoma. An area showing papillary carcinomatous degeneration.



FIG. 12. Pathological No. 2029-2. Syphilitic testicle. An area from a gumma, showing fibrous tissue and a nest of round cells.

tumor growth; there are metastatic cells in the veins of the cord.

Revised Diagnosis: Seminoma (same as preceding).

CASE IX. History No. 9863; Pathological Laboratory No. 3007.

Samuel B. Aged fifty-eight; admitted July 21, 1929; discharged July 29, 1929. Hydrocele of left side for three or four months occurring after trauma; gradual painless enlargement of the left testicle; repeated tapping and return of fluid.

Physical Examination: In left scrotum is a mass, not tender; transilluminates.

Preliminary Diagnosis: Hydrocele.

Operation: July 22, 1929. Winkelmann operation on left testicle followed by castration.

Pathological Diagnosis: Gumma of testis.

Gross Pathology: Tumor in the center of testis; has a geographical margin; hard and white.

giant cells. No necrosis is present.

Revised Diagnosis: Gumma (same as preceding).

CASE X. History No. 7130; Pathological Laboratory No. 2029.

Jacob L. Aged fifty-five; admitted Dec. 14, 1928; discharged Dec. 21, 1928. Inflammation of left kidney for tree years. Left testicle has been swollen for four weeks.

Physical Examination: Left kidney palpable; left testicle size of a goose-egg, hard, smooth, not attached to skin.

Preliminary Diagnosis: Luetic orchitis (by house surgeon).

Operation: Dec. 15, 1928. Left orchidectomy.

Pathological Diagnosis: In all probability it is syphilis of the testicle.

Gross Pathology: The tissue is firm homogeneous tissue which on section shows no cysts.

Microscopical Pathology: There is very great fibrosis; the fibrous trabeculae enclose

areas of granuloma; no giant cells are seen; a necrotic portion is noted.

Revised Diagnosis: Gumma of testis.

ORCHIDECTOMY

This operation is the logical and natural one. It is easy to perform. It has practically



FIG. 13. Pathological No. 2029-1. Syphilitic testicle. Another area, somewhat fibrous but more granular.

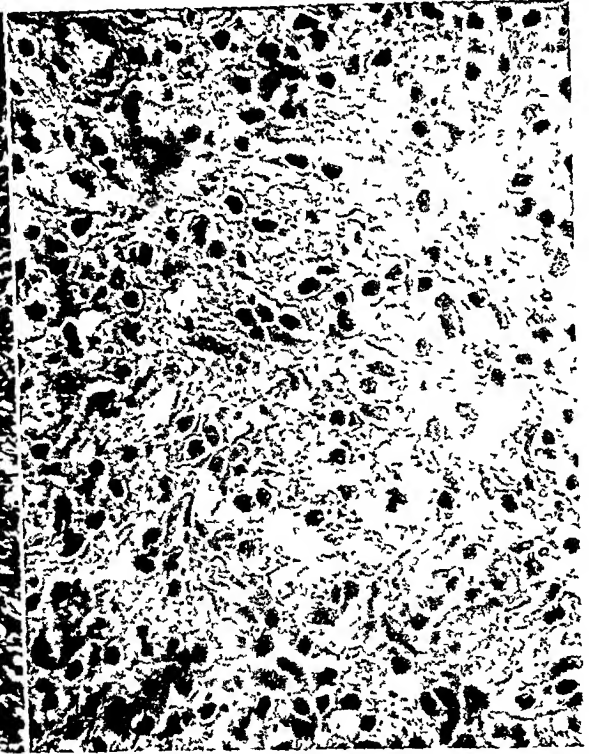


FIG. 14. Pathological No. 3007. Syphilitic testicle. Pure granuloma. This somewhat resembles spheroidal cell carcinoma (compare No. 2904, Fig. 4).

TREATMENT

Neoplasms of the testicle proper, are nearly all extremely malignant. Fortunately they are rare. Unfortunately their rarity prevents any urologist from acquiring any great amount of personal experience with them.

The operation of castration is of slight value although easy to perform. The radical operation is one of great difficulty and one requiring an extensive knowledge of the anatomy of a region seldom entered surgically. Hence the entire subject is in an unsatisfactory state, out of which radiotherapy, preoperative and postoperative, is said by its advocates to offer a ray of hope, but so far not enough unquestioned evidence has been accumulated to thoroughly systematize such claims and hopes.

no mortality. It is still the operation in vogue. Its results depend on whether the tumor cells are already disseminated, in paths which will be discussed later.

What are the results of simple orchidectomy?

Among the older writers Kober (1899) found that of 105 cases of "sarcoma" (this term was used at that time) so treated; only 9 patients were alive in three years.

Of 100 cases analyzed by Chevassu (1906) 19 patients were alive from four to ten years after operation. Of these, 16 had seminomata (spheroidal carcinomata) and 3 had malignant embryoma.

Tanner (1922) analyzed 600 cases of patients so operated. He was able to find reports of 465 traced cases. Of these only 5½ per cent were alive four or more years. Two patients died of metastases six years after operation.

Dew in 37 cases has one that he considers a cure; the patient is alive twenty-two years after operation.

practically never involved, except after operation and *exploratory puncture*.

Tumors rarely fungate, except in the

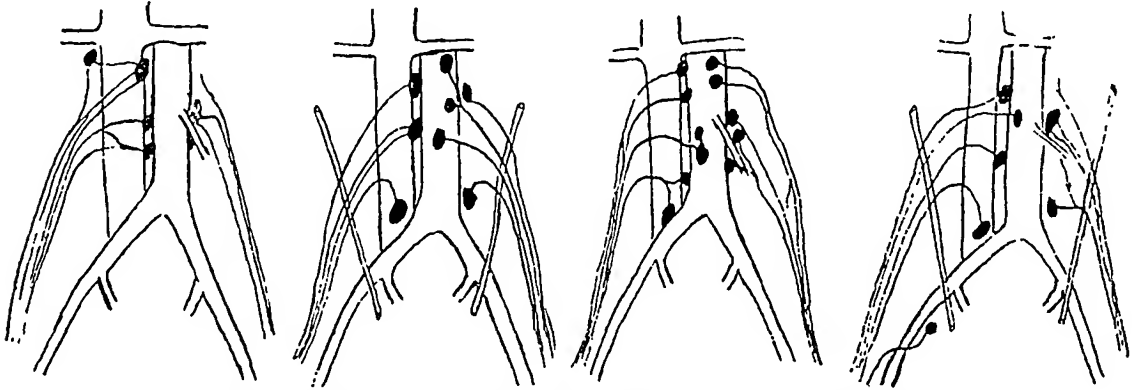


FIG. 15. Lymphatics of the testicle. (After Jamieson and Dobson.)

Hinman (1914) reports only 3 cured of 18 patients so operated on.

Dew (1925) reported 15 patients having embryomata whom he had followed up; of these all were dead of metastases except 4 recent cases, which were under twenty months, and two of these patients already had glandular metastases.

Dew followed up 6 carcinomata; 3 patients are alive, 1 two years, 1 one year and 1 twenty-two years after operation.

These results are similar to those that occurred in the period before the radical operation for carcinoma of the breast.

THE PATHS OF EXTENSION OF THE MALIGNANCY

Formerly when these tumors were considered sarcomata, it was a surprise that they should in most cases metastasize by a lymphatic route. This discrepancy was cleared up later, when it was found that sarcoma of the testicle was so rare, that it is doubtful in the minds of some authorities, whether a proved specimen exists. As soon as it was understood that the tumors were derived from epithelium, the lymphatic route of extension was understood.

There is no superficial lymphatic route from the testicle to the superficial inguinal glands, unless the skin of the scrotum is involved. This is very important as it is

latest stages and by this time the deep lymph channels are affected.

Whenever the superficial inguinal nodes are involved, if there has been no needling and no operation and the skin is movable over the tumor, they are involved in *retrograde fashion*, and are presumptive evidence that the deep lymphatics are involved, even though there are no palpable abdominal masses. Such a case is inoperable.

Primarily the spheroidal cell carcinomata and the malignant embryomata involve the deep lymphatics, the latter earlier and more regularly than the former.

According to the work of Jamieson and Dobson such tumors follow the spermatic cord to the ureter, and then enter the *primary* lumbar lymph nodes. These lie in front of the aorta and the vena cava. On the right side one or more nodes lie in the groove between the aorta and the vena cava. On the left side they lie to the left of the aorta and near the root of the mesenteric artery. The chain of nodes extends from the beginning of the common iliac artery to the renal vessels.

The *secondary* glands involved are:

- a. the primary glands of the opposite side,
- b. glands behind and between the great vessels, above and below the level of the renal veins.

When these secondary glands are involved, especially those behind the

great vessels, the masses are of course irremovable.

The superficial inguinal glands are never primarily involved, unless the tumor cells involve the skin of the scrotum. This occurs primarily only in the very late stage, when the neoplasm has attached itself to the scrotal skin, and has ulcerated through, producing a fungating mass. This condition is rarely seen at present. However, recurrent masses, after orchidectomy, act in the same manner.

The skin of the scrotum may be infected with tumor cells after tapping. This is unfortunate, as hydrocele is the commonest tumor in the scrotum. For this reason, and because an occasional case of hydrocele is cured by tapping, and because it is at times difficult to differentiate soft areas in a testicular mass from fluctuation, and because the transillumination test is sometimes unsatisfactory, scrotal masses are subjected to much indiscriminate needling for diagnosis.

The danger of infection of the skin is great and implantation of tumor cells into the skin means practically a fatal outcome even if surgery is done.

The only fortunate thing about testicular neoplasms is that the infection of the deep lymphatics is usually late, especially in the spheroidal carcinomata.

Some few testicular neoplasms metastasize through the veins like hypernephromata of the kidney. These are the extremely rare *genuine sarcomata* and *choriomata* a case of which later was described by McCallum. An excellent case report and review of the former subject were made by Cooke.

These are direct extensions into the lumina of the veins with in addition the distant transplantation of cell nests into the lungs and other organs.

THE RADICAL OPERATION

The preceding discussion of the extension and paths of metastases naturally points toward the futility of simple orchidectomy. Only a case without previous extension to

the deep chain of lymphatics will allow a cure after mere orchidectomy.

What can be done by removal of the lymphatic areas in addition to orchidectomy?

This operation is a formidable procedure. Does it give an additional percentage of cures?

Is this additional percentage of cures discounted by the increased percentage of direct surgical mortality?

HISTORY OF THE RADICAL OPERATION

The radical operation for malignant disease of the testicle bears the same relationship to simple castration that the radical operation for carcinoma mammae bore to simple breast amputation. The conception is the same and is based on the study of lymphatic areas quite far removed from the original site of the malignant disease.

In both cases the removal of these lymphatic areas prolonged the operation considerably and added to the shock. Also the dissection of fat containing lymphatic areas necessitates a dissection upon the sheath of large arteries and veins and requires surgical ability of high degree, and even with this increases mortality of the operation. It required some time for the surgical world to accept these risks but they are accepted as a matter of course in the case of surgery of the breast. The reception of the operation by surgeons has been slower in the case of the testicle.

As long ago as 1909, Bland-Sutton referred to simple orchidectomy as "the ancient operation of castration for malignant disease." While others such as Roberts in 1902 had unsuccessfully attacked retroperitoneal masses transperitoneally, it remained for Gregoire in 1905 to perform the first extraperitoneal operation. Cuneo followed in 1906 with the first successful operation. He was followed by Chevassu who developed the technique which was followed in France by Gosset, Fredet, Delbet, Michon and Panchet;

in England by Howard and Davies; in the United States by Hinman and others.

THE PROCEDURE

The spermatic cord is carefully exposed by a high inguinal incision. It is double clamped and divided by the *actual cautery*. The field is packed with alcohol soaked towels. The scrotal mass is carefully removed.

The surgeon should then slice the tumor entirely through for inspection, using a side table so as not to infect the operative field.

The gross pathological features are of great importance. They are as follows:

Tumors beyond first-size are usually *malignant embryomata*. These have a soft encephaloid consistency and are often yellow pink and reddish in spots, varicolored. They are more friable than the *carcinomata*. Neither *embryomata* nor *carcinomata* invade the tunica vaginalis except in the latest stages. The epididymis is usually involved and thinned out. *Embryomata* in nearly all cases have cyst-like cavities, ranging from pinhead to small cherry size. Some have a honeycomb appearance. The presence of these cysts is usually diagnostic, as they rarely occur in the *carcinomata*. (Our series has 1 case of a spheroidal carcinoma with cysts.)

The *spheroidal carcinoma* like the *embryomata* do not invade the tunica but are more likely to invade and replace the epididymis, which is solidly replaced *without caseous areas*, as occur in tuberculosis. There are however in some cases inspissated areas in the epididymis, which look somewhat like tuberculous epididymitis.

The cut section of the carcinoma is firmer than that of the *embryoma*; it has a pearly gray appearance and fleshy consistency like a "giant scallop." It looks like typical sarcomatous tissue. When small, part of the testicle may be identified. It is not as a rule as firm as the *luetie testis* and does not have in it the gummatous nodules with "geographic margins."

As a rule, neither of the two important malignant neoplasms of the testis is easily confused with tuberculosis, as the latter usually involves the epididymis and unless only the margin of the testis is involved, shows great liquefaction of the testicular tissue proper.

On the other hand, the *luetie testis* is at times likely to resemble the *carcinomata*. This is *very important* as in the literature there are reports of the removal of such testes and the subjection of the patient to the radical operation by mistake.

Grossly the diagnosis can usually be made by a competent observer. It is well however to have a frozen section made. The interpretation of frozen sections however is at times difficult, especially the differentiation between carcinoma and gumma, or *luetie testis* without gummatous areas. The presence of glands, cartilage, etc., in the *embryomata* makes their diagnosis by frozen section easier.

Having decided that one is not dealing with tuberculosis or syphilis, the surgeon changes his gloves, etc., and proceeds.

The incision is extended in a curved manner so as to follow the course of the iliohypogastric and ilioinguinal nerves.

Paraphrasing Hinman, the incision is extended upward from the upper end of the high inguinal incision in the line of the outer border of the rectus muscle, for a short distance; it then curves outward toward a point about a centimeter below the tip of the twelfth rib, and follows along the lower border of that rib for half its length.

The external oblique fibers are merely separated by the scalpel; the internal oblique, transversalis and a small part of the fibers of the *latissimus dorsi* must be cut across. Only the iliac branch of the iliohypogastric nerve is to be sacrificed, the hypogastric branch being spared.

The peritoneum with the intestines within it is pushed inward away from the posterior abdominal parietes. The ureter, the spermatic vessels and lymphatics strip up with the peritoneum, but the lymph nodes remain upon the aorta and cava. In

removing the lymph nodes it is easier to work from below upward but it is better to ligate the spermatic vein and artery above if possible. It may be necessary to ligate the inferior mesenteric vessels if the glands are matted together around them, and in animals ligation of these vessels has done no harm.

Rubber tubes with an exit from the back can be used for carrying radium for twelve to fourteen hours after operation.

The closure of the wound should be a hernioplasty.

RESULTS OF THE RADICAL OPERATION

The primary surgical mortality is of most import in an operation of this sort.

The operation was first performed in 1906.

Cairns in 1926 reported 17 cases done at the London Hospital without mortality. This is the only series in the literature without primary mortality.

Hinman in 1923 reported 79 cases from the literature, of which 9 were personal cases. Of these 79 patients operated by various surgeons, the mortality was 10 patients, or 13 per cent. In Hinman's own personal cases, one died from operation, 11 per cent.

Dew's experience is three operations with no deaths; one of these was not completed on account of the finding of irremovable masses.

THE CURE

A four-year period without recurrence is not enough, but most authorities agree upon a six-year period.

Dew says that barely 60 per cent of the cases seen appear to justify the operation and in Hinman's collection of 79 cases, 22 which were submitted to operation were found to be inoperable after the surgical exposure was made. The operation was really successfully done in only 57 of the 79 patients.

In 24 of Hinman's patients in whom metastases were found and removed, 6 died later of metastases; 1 was accidentally

killed; 15 survived (4 of them more than four years). All of these would have died of cancer without surgery or with mere orchidectomy.

In 25 of Hinman's patients in whom the pathologist could find no malignancy in the lymphatic areas removed, 8 died of metastases; 1 was untraced; *but 13 are living*. Some of these 13 might have survived with mere orchidectomy.

A comparison of these figures with those of mere orchidectomy, even with an operative mortality of more than 10 per cent is *in favor of the radical operation*.

RADIOTHERAPY WITH OR WITHOUT SURGERY

Barringer and Dean report from the Memorial Hospital studies which are suggestive. Their cases are too few in number and not followed to the six-year period, but if they prove satisfactory, they will give better results than the radical operation has shown, to say nothing of having eliminated the mortality of the radical operation.

Dean advises high voltage x-ray to the loin and low voltage x-ray to the scrotum; this is continued for three or four weeks. Then a careful orchidectomy is done. Postoperative radiation treatment is then continued for three to four months or even longer.

Of 39 patients who had orchidectomy done before they came to Memorial Hospital and in which recurrence was present:

24 are dead

7 are lost to record

8 are alive; 4 over four years and the longest seven years and seven months.

Of 6 primarily operated cases, which were considered to be operable:

1 patient died of metastases in ten months

1 was not followed longer than fifteen months

4 were alive thirteen to forty-five months.

These figures are *very suggestive*, although they are suggestive merely until we amass more cases and studies over longer periods.

CONCLUSIONS

1. That for practical purposes neoplasms of the testicle are all malignant, the malignant embryomata being somewhat more malignant than the spheroidal cell carcinomata.

2. That sarcoma of the testicle is among the rarest of testicular neoplasms.

3. That the route of metastasis is usually lymphatic.

4. That simple castration is of little avail, curing only about 5 per cent of cases that are followed four to six years.

5. That the radical operation seems to give a considerably higher percentage of cures, even discounted by its primary surgical mortality.

6. That before deciding on the radical operation, the testicle should be studied in the operating room jointly by the surgeon and pathologist, grossly and microscopically, following a certain carefully described technique.

7. That preoperative and postoperative radiation in conjunction with careful castration may be the hope of the future, but not enough material has so far been recorded to decide in favor of this technique.

Thanks are due Dr. A. A. Eisenberg, Director of Laboratories, and to the Surgeons of Sydenham Hospital for the use of the material.

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PERFORATED PEPTIC ULCER*

A STATISTICAL AND ROENTGENOLOGICAL STUDY OF 82 CASES

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FROM 1917 to 1930 (both years inclusive) there were operated upon at St. Luke's Hospital 82 patients with perforated peptic ulcers.

with sufficient regularity to justify any statistical conclusions. Two cases had a 4-plus Wassermann reaction in the blood.

ETIOLOGY

Of these cases, 72 were males and 10 females (Table I). The greatest age inci-

TABLE I
SEX AND AGE

	Males	72	Per Cent	87.8
	Females	10		12.2

Age in years.....	1-10	11-20	21-30	31-40	41-50	51-60	61-
Number.....	1 (3 yrs.)	4	13	24	20	14	6
Per cent.....	1.2	4.8	15.8	29.5	24.4	17.0	7.0

Total cases, 82. (Two with 4-plus Wassermann reactions.)

dence was in the two decades between thirty-one and fifty with the decades preceding and following this period showing slightly more than half the ten-year occurrence in the period just given. The youngest patient was three years old and the oldest sixty-nine.

The occupations covered by the patients included in this series covered a very wide range. However, an incidence of nearly 10 per cent in chauffeurs appears to be far out of proportion. This can possibly be accounted for by their irregular hours of eating and, often, their great rush in poor restaurants. The other occupations included in the list occur approximately in the same proportion as their incidence in the general population.

Focal infection probably plays a large part in the etiology. Bad teeth are noted frequently, and often infected tonsils, but their presence or absence was not noted

HISTORY

The statement has often been made that before operation in these cases previous indigestion is frequently denied but that nearly always after operation careful questioning reveals a definite indigestion history. The preoperative histories of these cases were positive for previous indigestion in 75 cases, negative in 6 and one not given. The duration of indigestion history is shown in Table II. Sixty-six patients had

TABLE II
HISTORY OF INDIGESTION
75 positive, 6 negative, 1 not stated

Duration	3-7 Days	8-14 Days	15-30 Days	31-45 Days	46-60 Days	2 Mo. or over
Number	4	2	1	1	1	66

had indigestion for a period of two months or longer.

The period from the time of perforation to admission into the hospital is given in Table III. Two cases perforated while in

TABLE III
HOURS FROM PERFORATION TO ADMISSION*

Hours.....	-6	7-12	13-24	25-48	49-72	73-96	Longer Period	Not Stated
Total cases...	30	11	6	4	6	2	19	3
Lived.....	28	10	4	3	3	1	14	2
Died.....	2	1	2	1	2	1	5†	1
Mortality, † per cent....	6.7	9	33	25	33	50	26.3	66

* If in hospital from perforation to operation.

† One perforated after gastroenterostomy for duodenal ulcer—died. Had perforated also a long time before according to operative findings.

‡ Total mortality, 18.3 per cent.

* Submitted for publication October 24, 1931.

the hospital under ulcer treatment. The duration for these two was figured from the time of perforation to the time of operation. One case perforated after a gastroenterostomy had been done for an ulcer in the first part of the duodenum. The mortality increased markedly with the increase in time elapsed between perforation and operation.

The immediate history in practically all of the acute perforations was classical. In those cases having perforated a considerable time before operation or when the perforation was extraperitoneal the histories were not typical. Sixty-five patients gave a history of sharp, sudden, severe onset of the pain. Sixteen reported moderate pain only. Forty had vomited while 6 were only nauseated. Sixty-nine had epigastric pain. The pain was generalized over the abdomen in 8 and localized in the right lower quadrant in 4. In 2 of the latter a diagnosis of ruptured appendix was made and the abdomen opened through a McBurney's incision. In the case which perforated postoperatively the patient complained of no more pain than that expected after an abdominal operation such as she had had. The perforation was found at autopsy. A case, similar in that it had no symptoms, has been reported by Gregoire.

PHYSICAL FINDINGS

As to physical findings, board-like rigidity was the most constant, being found in 56 cases. There was a slight rigidity in 25. Liver dulness was stated as obliterated in 12, as present in 12 and not stated in 61. Fluid in the flanks was demonstrated in 3 cases, noted as absent in 9 and not stated in 73. One case perforated postoperatively and had no physical findings referable to this condition. In 3 cases definite history and physical findings were not given.

PATHOLOGICAL FINDINGS

The site of perforation (Tables IV A and B) was in the first part of the duodenum in 57. The pyloric region was the next most

common site with 12, while the second part of the duodenum and upper portion of the stomach were much less frequent sites, their occurrence being 7 and 6 respectively.

TABLE IV A
SITE OF PERFORATION

Site.....	Stomach Upper	Stomach Lower	First Part Duodenum	Second Part Duodenum
Total cases....	6	12	57	7
Lived.....	5	10	45	7
Died.....	1	2	12	0
Mortality, per cent.....	16.6	16.6	21.0	0

Fifty-one were found perforated into the free peritoneal cavity at the time of operation, with a mortality of 19.6 per cent. When the perforation had been sealed off the mortality was reduced to 12 per cent. This condition was found in 25 cases. The

TABLE IV B
SITE OF PERFORATION

Site.....	Perforation into Free Peritoneal Cavity	Perforation Sealed or Walled Off	Perforation Retroperitoneal or into Pancreas
Total cases....	51	25	6
Lived.....	41	22	4
Died.....	10	3	2
Mortality, per cent.....	19.6	12.0	33.3

high mortality in those which had perforated retroperitoneally or into the pancreas was undoubtedly the result of the large, long and difficult operations performed on these patients. The presence or absence of fluid and gas corresponds to the physical findings when they were noted in the examination. The size of the perforation and the amount of induration apparently bore no relation to the history or physical findings.

POSTOPERATIVE MORTALITY AND COMPLICATIONS

The total postoperative mortality for the 82 cases was 15, i.e., 18.3 per cent. The causes of death in relation to the site of perforation, time of perforation and the

operation performed are shown in Table v. A severe peritonitis, noted as occurring in 8 cases, is the most frequent. With one exception this occurred even though the peritoneal cavity had been drained. Pulmonary complications occurred in 40 per cent

TABLE V
POSTOPERATIVE DEATHS

Time from Perforation to Operation	Pre-perforation Symptoms	Location of Perforation	Operation	Cause of Death	Time of Death
4 hours	10 years	1st part duodenum	Inversion	Lobar pneumonia both upper lobes. (Group III). Persistent thymus	6 days
5 hours	Many years	Stomach—lesser curvature near pylorus	Cauterized. Inversion. Posterior gastro-enterostomy	Lobar pneumonia, right lower	8 days
6 hours	Many years	1st part duodenum	Inversion. Posterior gastroenterostomy	Peritonitis. Urinary suppression	2½ days
9 hours	Many years	Upper third lesser curvature	Inversion. Anterior gastroenterostomy	Shock. Peritonitis	36 hours
24 hours	6 weeks	1st part duodenum	Inversion	Peritonitis	22 hours
24 hours	10 years	1st part duodenum	Inversion	Peritonitis	4 days
28 hours	10 months	1st part duodenum	Inversion	Peritonitis	2 days
72 hours (new 6 hours)	5 years	1st part duodenum	Inversion. Posterior gastroenterostomy	Shock. Peritonitis	36 hours
73 hours	Many years	1st part duodenum	Inversion	Shock. Peritonitis	4 hours
96 hours	6 years	1st part duodenum	Inversion. Jejunostomy	Bronchopneumonia (right lower). Localized peritonitis	13 days
2 months	5 months	1st part duodenum	Inversion. Posterior gastroenterostomy. Appendectomy	Pulmonary embolus	12 days
2 months ?	Many years	1st part duodenum	Billroth II	Duodenal fistula. Inanition	13 days
Old	4 years	Stomach, posterior pyloric region	Pólya resection	Bronchopneumonia	7 days
Old	10 years	1st part duodenum	Cauterized. Inversion. Posterior gastroenterostomy. Cholecystectomy	Pulmonary edema. Cardiac failure	24 hours
Old	32 years	1st part duodenum	Posterior gastroenterostomy	Postoperative reperforation. Peritonitis	12 days

of the fatal cases. The other causes of death do not seem different from those expected in any similarly dangerous list of operations.

The frequency of pulmonary complications (43.3 per cent of the total number of complications) seems quite remarkable (Tables VI and VII). The limitation of

frequent after spinal or local anesthesia as after ether.

Separation of the wound occurred five times. This evidently indicates that more of the wounds should have been drained, at least to the peritoneum, and that those which were drained should have been drained more thoroughly. However this factor appears to have no relation to the mortality. Duodenal fistula occurred three times and caused one death by inanition. The other two closed spontaneously. Two of these occurred in cases in which at operation the perforation was thought to be sealed off securely and no attempt made at further closure. The remaining complications do not appear remarkable.

Peritonitis is not considered among the complications as all these cases have a contaminated peritoneum at the time of operation.

TABLE VI
POSTOPERATIVE COMPLICATIONS
(Peritonitis not included)

Bronchopneumonia	6
Separation of wound	5
Duodenal fistula	3
Hemorrhage	3
Lobar pneumonia	3
Shock	3
Bronchitis	1
Cardiac failure	1
Massive collapse	1
Obstruction (high)	1
Pulmonary edema	1
Pulmonary embolus	1
Urinary suppression	1
Total	30

TABLE VII
PULMONARY COMPLICATIONS

	Number	Mortality, Per Cent
Bronchopneumonia	6	33 3
Lobar pneumonia	3	66 6
Pulmonary embolus	1	100 0
Pulmonary edema	1	100 0
Massive collapse	1	0 0
Bronchitis	1	0 0
Total	13*	46 0†

* This represents 43 per cent of all the complications and an incidence of 15.8 per cent in the total number of cases.

† This is 40 per cent of the total mortality and a mortality of 7.3 per cent of the total number of cases.

excursion of the diaphragm and reduced vital capacity are probably the two major factors in causing this high percentage. As would be expected bronchopneumonia and lobar pneumonia head the list of pulmonary complications. These complications (i.e., pulmonary) occurred in 15.8 per cent of all the cases with a mortality of 7.3 per cent or 40 per cent of the total mortality. Nearly every case had ether anesthesia. Local infiltration and field block might possibly have reduced these figures, but recent figures tend to show that pulmonary complications are at least as

ULTIMATE PROGNOSIS

Of the 67 patients surviving operation, 59 were followed up for one year or more (Tables VIII A and B). Of these, 38 were fol-

TABLE VIII A
FOLLOW-UP

Lived	67
Followed up	59
Remaining free from symptoms.	40
Per cent of followed with symptoms	32.2

Years followed...	1	2	3	4	5	6	7	8	9	10	11	12	13
Remaining free from symptoms.	3	4	1	4	3	8	6	4	2	3	0	1	1
With symptoms	3	1	3	2	2	3	1	1	0	0	1	2	0

TABLE VIII B
FIVE YEAR "CURES"

Cases followed 5 years or longer.	38
Remaining free from symptoms	28
With symptoms	10
Percentage of 5 year "cures"	74*

* Not allowing reduction due to proportionate number of postoperative deaths.

lowed for a period of five years or more, of which 28 had remained free from symptoms following the original operation up to the

time when last seen (i.e., 74 per cent five year "cures"). Of the other 10 patients some have been symptom-free for periods of less than five years from subsequent surgical procedures.

Among the 59 followed cases, 18 had recurrence of symptoms leaving 67 per cent remaining free from symptoms up to the time when last seen. Seven patients with a recurrence of symptoms subsequently had posterior gastro-enterostomies performed and none of these has had any return of symptoms after this, their second operation. Of the 3 patients operated on upon again later because of another perforation, two have had no further symptoms. The remaining 8 when last seen or at the present time, whichever the case might be, were controlled by diet and medication.

OPERATIVE PROCEDURES

Simple inversion (Table ix) was the operation performed the greatest number of times. The percentage of cases remaining free from symptoms was 44 per cent but the mortality was only 15.4 per cent. It

TABLE IX
TYPES OF ORIGINAL OPERATION

Operation	Total	Followed	Cured*	Symptoms	Deaths	Per Cent Cured*	Per Cent Mortality
Inversion alone.....	39	39	15	14	6	43.0	15.4
Inversion and cauterization.....	3	3	2	1	0	66.6	0.0
Inversion and gastroenterostomy....	30	19	16	3	7	61.2	23.3
Excision alone.....	2	2	1	1	0	50.0	0.0
Excision and pyloroplasty.....	2	2	2	0	0	100.0	0.0
Excision and gastroenterostomy....	2	2	2	0	1	100.0	0.0
Polya.....	3	2	2	0	1	66.6	33.3
Billroth II.....	1	1	1	0	1	0.0	100.0

* Cases not followed up excluded from totals in figuring percentage of cures. This gives a lower figure than is absolutely correct because only the proportionate number of deaths should be included. By cured is meant remaining free from symptoms up to the time when last seen.

must be recalled that the extremely bad risks are all automatically relegated to this list.

Inversion plus posterior gastroenterostomy was the next most frequently used operation. The percentage of cases remaining free from symptoms was increased by nearly half but the mortality was likewise increased by half. When we consider that, of the 7 patients having a gastroenterostomy subsequent to a simple inversion, none died and none has had a recurrence of symptoms, the added cures by gastroenterostomy at the original operation by no means appear to justify the increased mortality.

The other operative procedures were used too infrequently for any conclusions to be drawn from their results.

ADDITIONAL SURGERY

The additional surgery (Table x) (i.e., not including that done on the stomach

TABLE X
ADDITIONAL SURGERY
(With Original Operation)

Inversion	
Plus jejunostomy for ileus.....	1
Died.....	1
Excision and pyloroplasty	
Plus cholecystectomy.....	1
Remaining free from symptoms.....	1
Inversion and gastroenterostomy	
Plus cholecystectomy.....	1
Died.....	1
Plus appendectomy.....	5
Remaining free from symptoms.....	3
With symptoms.....	1
Died.....	1

and duodenum) at the time of the original operation was performed as circumstances dictated. In 2 cases the gall bladder was so involved that it was removed. In 1 late case jejunostomy was performed because of an already present ileus, but with no apparent effect on the ultimate outcome.

In 2 cases the appendix was removed when a McBurney incision was made because of a wrong diagnosis and before the upper rectus incision was made. The other 3 appendectomies were incidental when the surgeon felt the patient's condition permitted this procedure. The mortality of 20 per cent in the 5 cases having appendectomies is above the total when it

should have been lower as the operation was performed on supposedly better risks. This again argues in favor of the least possible surgery at the time of the original operation.

SUBSEQUENT OPERATIONS

Subsequent operations (Tables XI A, B, C and D) were performed fourteen times on

TABLE XI A
SUBSEQUENT OPERATIONS

Posterior Gastroenterostomy for Return of Symptoms*

Time after First Operation	Original Operation	Site of Perforation	Ulcer Causing Symptoms
6 months....	Inversion	2nd part duodenum	Same
10 months....	Inversion	Prepyloric	Same
18 months†...	Inversion	1st part duodenum	Same
19 months....	Inversion	1st part duodenum	Same
2½ years....	Inversion	1st part duodenum	Same. 2 ulcers palpated
5 years and 3 years‡....	Excision	1st part duodenum	Prepyloric
Several years..	Inversion	1st part duodenum	Same

* All seven have remained free from a return of ulcer symptoms.

† Temporary duodenal fistula. Jejunostomy for obstruction with complete and permanent relief.

‡ Ulcer excised and closed at two previous perforations both at the same site.

TABLE XI B
SUBSEQUENT OPERATIONS
For Reperforations

Time after 1st Operation	Original Operation	Site of 1st Perforation	Site of 2nd Perforation	Operation	Result
1 year....	Inversion	1st part duodenum	Same	Inversion	Slight symptoms
1 year....	Inversion	2nd part duodenum	Same	Inversion	Free from symptoms
20 months.	Excision	1st part duodenum	Same	Excision	Ulcer symptoms*

* Symptoms recurred three years later. Prepyloric ulcer found. Posterior gastroenterostomy resulted in no return of symptoms.

12 patients. Seven of these were posterior gastroenterostomies for a recurrence of symptoms with complete relief to the present time in all. One of the cases developed a postoperative obstruction for

TABLE XI C
SUBSEQUENT OPERATIONS
For Hemorrhage and Continued Vomiting

Time after 1st Operation	Original Operation	Site of Perforation	Operation	Result
3 weeks....	Inversion	High on lesser curvature	Cauterization of ulcer. Plastic repair of hour-glass deformity	Free from symptoms

TABLE XI D
SUBSEQUENT OPERATIONS
For Marginal Ulcer

Time after 1st Operation	Original Operation	Site of Perforation	Operation	Result
7 years....	Inversion and posterior gastroenterostomy	1st part of duodenum	Ulcer excised. Gastroenterostomy undone. Pyloroplasty	Slight symptoms. Controlled by hyperacidity routine

which a jejunostomy was done with relief of the obstruction and no return of symptoms to the present time.

Three cases perforated a second time. Two of these patients had simple inversion and of these one has remained symptom-free. The third patient had an excision with closure and remained symptom-free for three years following the second operation. The two perforations were at the same site in the duodenum. At the third operation, done for a recurrence of symptoms, a prepyloric ulcer was found and a gastroenterostomy performed. This patient has had no symptoms since. This is the only patient with a record of the recurrence being at a different site.

The other two operations were, one for hemorrhage three weeks postoperative and one for marginal ulcer seven years after the original operation.

POSTOPERATIVE ROENTGENOGRAPHIC STUDIES (FIGS. 1-27)

This work was undertaken primarily to determine whether or not postoperative roentgen ray studies of these cases would differentiate cures and activity and foretell the probability of reperforation.

Of the 58 cases followed up, 33 have had postoperative roentgen ray examinations of the gastrointestinal tract one or more times. The majority showed a permanent irregularity or filling defect at the site of the perforated ulcer. Only those having a return of symptoms showed spasm and tenderness to pressure at the point of the deformity with hypermotility of the stomach.

NONOPERATIVE MORTALITY

But 2 patients followed up have died since leaving the hospital. One death occurred five years postoperative and was due to pulmonary and laryngeal tuberculosis. The other was a case which remained symptom-free for three years after inversion and posterior gastroenterostomy for a perforated gastric ulcer. This patient then returned with abdominal pain and vomiting. Examination revealed a large mass in the epigastrium which was diagnosed as gastric carcinoma by roentgenograms. No post-mortem examination was obtained. This was the only patient in the entire list who to date has returned with a gastric malignancy giving an incidence of 1.2 per cent.

RATIONALE OF TREATMENT

A review of the recent literature on the subject reveals a great disparity in the conclusions as to what the proper treatment of perforated peptic ulcers may be. A great number of surgeons, after years of careful follow-up studies of their cases and checking over their comparative mortality figures, lean more and more toward conservatism. On the continent a great many recommendations are put forward for gastric resection at the time of the original

operation. The diverse procedures involving varying amounts of surgery between these two extremes are recommended frequently.

From this study the conclusion is made that the least possible surgery at the time of the original operation is very much worth while and results in a marked lowering of the mortality figure. Additional operative procedures should be left for a subsequent time and done when indications dictate. Such subsequent operations carry a much lower mortality than the amount they add to the original mortality figure. Our results show also that approximately 44 per cent of the cases will have no cause for later surgery and should be given the benefit of the freedom from the increase in mortality due to any additional surgery.

In case a pyloric stenosis or obstruction is found at the time of the original operation, a nasal (Levine) tube may be passed into the stomach and guided through the pylorus. This permits feeding until the time when the patient's condition permits a second operation.

Nothing is given for twenty-four hours postoperative and the diet is then ordered for the next ten days as in any gastric operation. Following that we feel it to be very much worth while to proceed with a regular ulcer treatment, Sippy, Bastedo or Lenhartz, as the operator may desire. From the time of discharge the patient should be under the careful observation of a competent gastroenterologist who regulates the subsequent care and determines the necessity for additional operative procedures.

CASE HISTORIES*

SIMPLE INVERSION OF ULCER

CASE 1. (Dr. J. J. Westermann.) D. W., male, aged forty-five, was admitted on January 31, 1925. Six hours before admission he had a severe sharp sudden pain above the umbilicus which spread to the rest of the abdomen. He then vomited. For one week he had had a burning pain in the epigastrium relieved by

* Including only those which have had postoperative roentgenograms.

food. Examination showed board-like rigidity of the entire abdomen, with liver dullness present.

Immediate operation revealed a large amount

The patient has had no return of symptoms since the operation.

CASE II. (Dr. J. J. Westermann.) M. M.,

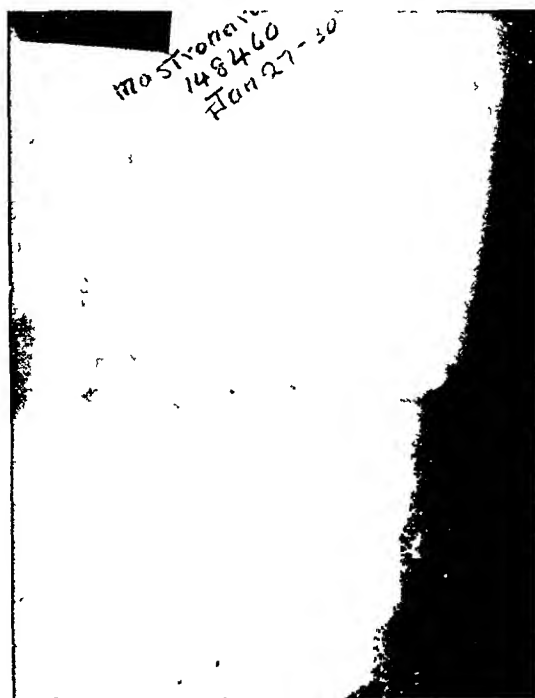


FIG. 1. Case II, five years and two months postoperative to simple inversion of perforation, 1 cm. beyond pyloric ring. Deformity of cap was constant. No symptoms since operation.



FIG. 2. Case II, six years postoperative. Deformity of cap was constant. No symptoms since operation.

of turbid fluid in the abdomen. On the anterior surface of the second portion of the duodenum was an indurated area 2.5 cm. in diameter, in the center of which was a 2 mm. perforation. The perforation was inverted and a tab of omentum turned over the suture line. The peritoneal cavity was drained.

Convalescence was uneventful and the patient was discharged on February 16, 1925, without symptoms.

Postoperative roentgen ray examination on November 21, 1925, showed dilatation of the stomach with persistent irregularity of the duodenum. Peristalsis was hyperactive and at six hours there was no retention.

Another, on April 5, 1927, showed a persistent defect in the duodenum and the stomach empty at six hours.

On December 18, 1927 the stomach showed normal emptying with a constant defect in the duodenum.

On November 17, 1930 it appeared normal with a large smooth cap. No abnormality of the duodenum was noted.

male, aged thirty-six, was admitted on December 4, 1924, because of severe epigastric pain which had begun suddenly six hours before. He did not vomit. For the preceding three months he had had pain one to two hours after meals. Examination showed board-like rigidity of the upper abdomen with obliteration of the liver dullness.

Immediate operation revealed considerable bile-stained fluid and gas in the peritoneal cavity. One centimeter below the pyloric ring on the anterior surface of the duodenum was a 3 mm. perforation. The ulcer was excised by a longitudinal elliptical incision and the defect sutured transversely. A tab of omentum was drawn over the suture line and a rubber dam drain inserted into the peritoneal cavity.

Convalescence was uneventful and the patient was discharged without symptoms on December 21, 1924.

Postoperative roentgen ray examination on January 27, 1930 (Fig. 1) showed a large stomach, normal in shape and position. The peristalsis was deep and vigorous. The cap was

persistently irregular but without spasticity, tenderness or retention. This was the appearance of an old healed ulcer.

the suture line covered with a tab of omentum. No drain was used.

Convalescence was uneventful and the

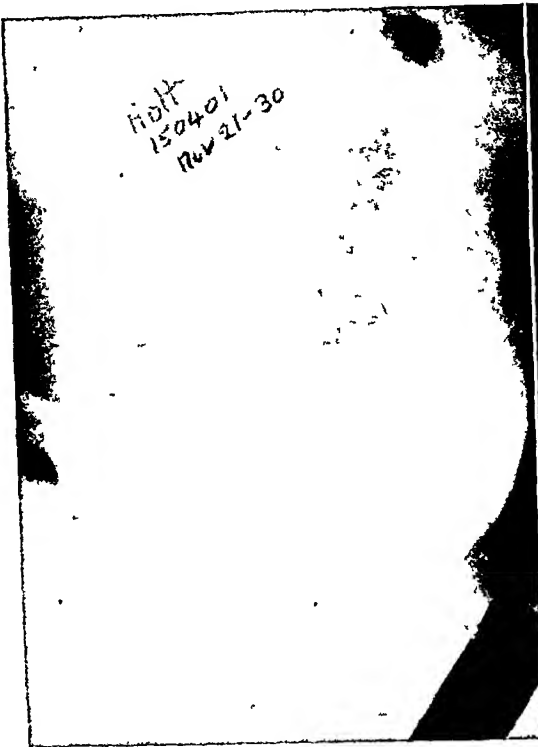


FIG. 3. Anteroposterior roentgenogram of Case v, seven months postoperative to simple inversion of perforated ulcer high on lesser curvature. Large perforating ulcer shows at site of original perforation. Mild ulcer symptoms.

Another on December 8, 1930 (Fig. 2) showed the stomach normal with some constant deformity of the first portion of the duodenum. There was no spasticity. This indicated a healed process.

He has had no return of symptoms to the present time.

CASE III. (Dr. F. W. Solley.) M. L., male, aged forty-four, was admitted on September 18, 1928, because of severe pain in the epigastrium which had begun suddenly six hours before. He vomited. For several years he had had epigastric pain and gas two hours after meals. Examination showed board-like rigidity of the abdomen.

Immediate operation revealed a large amount of bile-stained fluid in the peritoneal cavity. On the anterior surface of the duodenum just past the pyloric ring was an indurated area 3 cm. in diameter with a 5 mm. perforation in its center. The perforation was inverted and

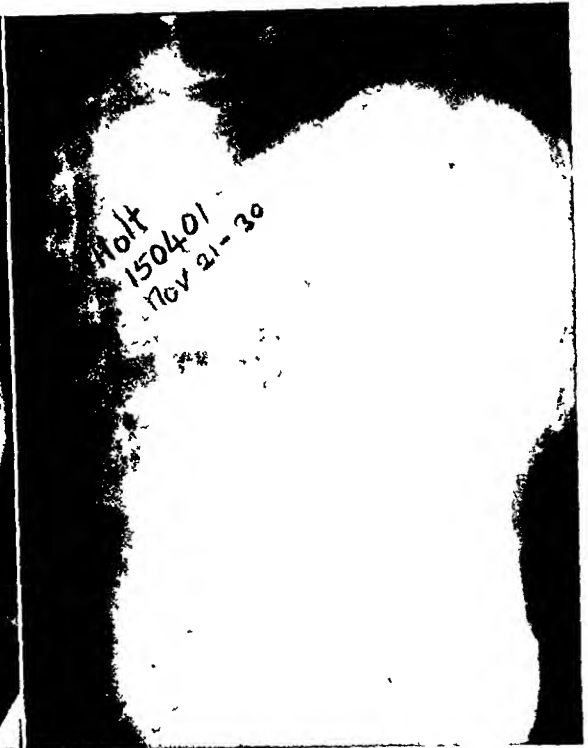


FIG. 4. Oblique roentgenogram of Case v.

patient was discharged without symptoms on October 5, 1928.

Postoperative roentgen ray examination on October 4, 1928 showed hyperperistalsis. The cap contained a permanent defect with considerable spasticity and tenderness. There was no six hour retention.

This patient continued to have epigastric pain before meals to the time when he was last seen one year after operation.

CASE IV. (Dr. R. W. Bolling.) J. S., male, aged thirty-three, was admitted May 30, 1922. One and one-half hours before admission he had had a sudden severe pain in the epigastrium. For the preceding eight years he had had epigastric pain after meals, relieved by soda. Examination showed board-like rigidity but no fluid wave.

Immediate operation revealed only a small amount of fluid in the peritoneal cavity. In the anterior wall of the duodenum 3 cm. distal to the pyloric vein was a 3 mm. perforation. The perforation was inverted and the suture line covered with a tab of omentum.

During convalescence he had some indigestion and upon discharge on June 15, 1922, was referred to the stomach clinic.

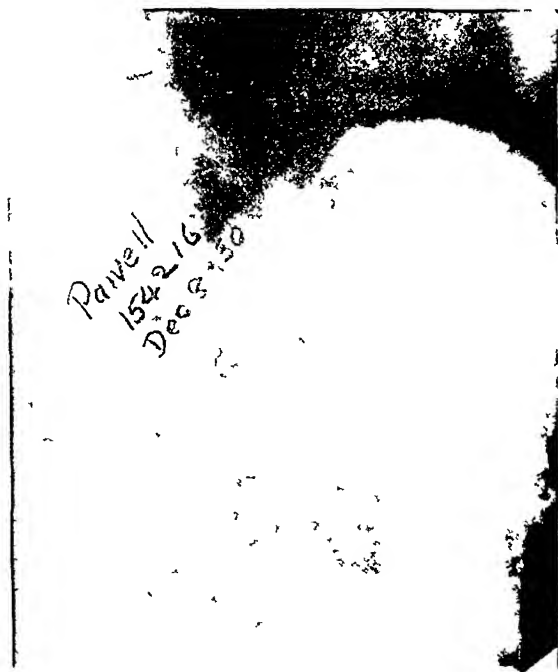


FIG. 5. Case vi, eighteen months postoperative to simple inversion of perforation just beyond pyloric ring. Deformity of cap was constant. No symptoms since operation.

Postoperative roentgen ray examination on August 17, 1922 showed a normal stomach.

He had no symptoms from the time of discharge until last seen on October 4, 1923.

CASE V. (Dr. M. K. Smith.) C. H., male aged thirty-three, was admitted on May 3, 1930. Two and one-half hours before admission he had had a sudden severe sharp pain in the left upper quadrant. For the eighteen months preceding he had had pain in the epigastrium one hour after meals lasting two to three hours, relieved by alkaline powders or food. For two months he had had tarry stools. No vomiting occurred at any time. Examination showed tenderness and rigidity of the entire abdomen, board-like in the upper abdomen. Liver dulness was present and no fluid wave could be demonstrated.

Preoperative roentgen ray examination showed no gas beneath the diaphragm.

Immediate operation revealed an area of induration 5 cm. in diameter with a 5 mm. perforation in its center near the cardia

on the lesser curvature. The left lobe of the liver was adherent to a part of the indurated area. The peritoneal cavity contained very little free fluid. The perforation was inverted and the suture line covered with a tab of omentum. No drains were used.

Convalescence was uneventful but for a post-operative temperature. *Roentgenograms showed a pneumonic process in the right lower lobe.*

He was discharged symptom free on May 25, 1930.

Postoperative roentgen ray examination on November 21, 1930 (Figs. 3, 4) showed a large perforating ulcer on the posterior wall of the stomach midway between the cardia and pylorus. There was no six hour retention.

Up to the present time the patient has continued to have mild ulcer symptoms even though he is on an ulcer diet.

CASE VI. (Dr. W. F. MacFee.) R. P., male, aged thirty-five, was admitted on March 7, 1929. One and one-half hours before admission he had had a sudden severe sharp pain above the umbilicus with nausea but no vomiting. He denied any previous gastrointestinal history. Examination showed board-like rigidity of the entire abdomen with obliteration of the liver dulness.

Immediate operation revealed considerable gas and some bile-stained fluid in the peritoneal cavity. Just beyond the pyloric ring was a 5 mm. perforation surrounded by a moderate amount of induration. The perforation was inverted and the abdomen closed without drainage.

A severe bronchitis developed and on the sixth day with a spasm of coughing the wound broke open. It was resutured and healed firmly. On April 3, 1929, he was discharged without symptoms.

Postoperative roentgen ray examination on December 8, 1930 (Fig. 5) showed a normal stomach. The duodenum contained a persistent deformity with no spasticity or tenderness.

The patient has had no return of symptoms up to the present time.

CASE VII. (Dr. H. J. Shelley.) M. P., male, aged thirty, was admitted on August 30, 1930. Seven hours before he had had a sudden severe epigastric pain which continued. This was associated with nausea but no vomiting. For six years he had epigastric pain one hour after meals. Examination showed

board-like rigidity, most marked in the right upper rectus. Liver dulness was present and there was no demonstrable fluid wave.

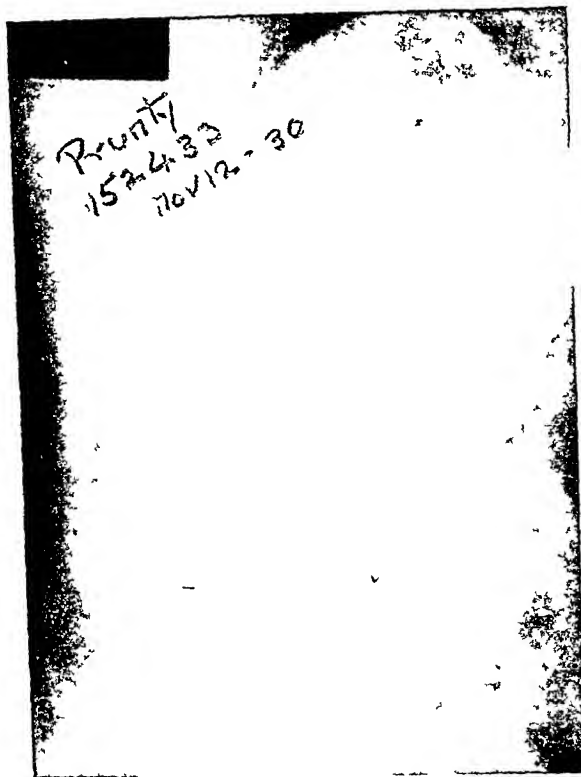


FIG. 6. Case VII, three months postoperative to simple inversion of perforation of first part of duodenum. Slight constant irregularity of cap. No symptoms since operation.

Immediate operation revealed a small amount of thick bile-stained fluid in the peritoneal cavity. The duodenum was adherent to the under surface of the liver. In the anterior surface of the first portion of the duodenum was a 3 mm. perforation surrounded by a small area of induration. The perforation was inverted and a tab of omentum turned over the suture line. The peritoneal cavity was drained.

Convalescence was complicated by a bronchopneumonia but the patient was discharged on September 30, 1930, without symptoms.

Postoperative roentgen ray examination on November 12, 1930 (Fig. 6) showed a regular stomach which emptied normally. Although there was no evidence of the site of the perforation, the cap did not have an entirely regular outline. No spasticity was noted.

He has had no return of symptoms up to the present time.

CASE VIII. (Dr. R. W. Bolling.) H. F., male, aged thirty, was admitted on March 21, 1923. Three hours before admission he

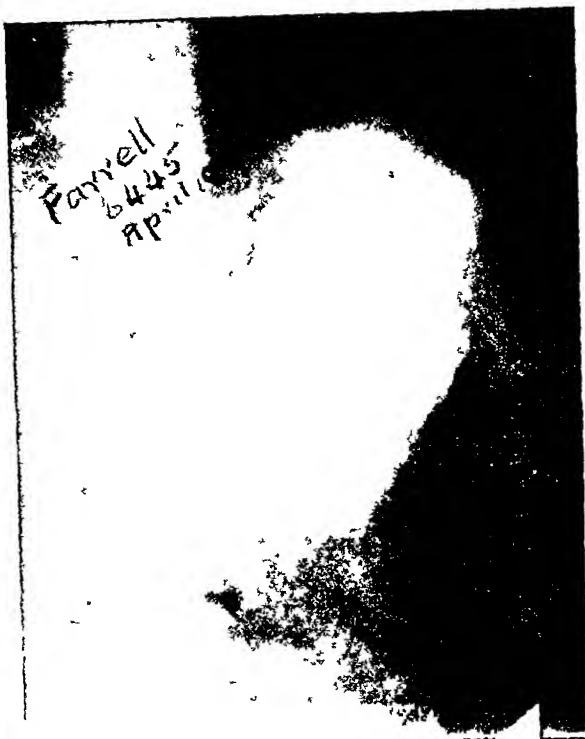


FIG. 7. Case VIII, five years postoperative to simple inversion of perforation just beyond pyloric ring. Irregularity of cap was constant. No symptoms since operation.

had had a sharp sudden severe pain in the right lower quadrant with vomiting. For periods during the preceding ten years he had had pain in the epigastrium two hours after meals. In 1916 he had been on an ulcer diet for five months. Examination showed marked rigidity of the abdomen particularly in the epigastrium.

Immediate operation revealed a small amount of viscous fluid in the peritoneal cavity, collected chiefly in the right lumbar gutter. Just distal to the pyloric vein was a large area of induration in the center of which was a 4 mm. perforation. The perforation was inverted and a tab of omentum drawn over the suture line. A rubber dam drain was inserted into the peritoneal cavity.

Postoperative roentgen ray examination on April 19, 1928 (Fig. 7) showed an irregular cap without spasm.

Another study on January 23, 1931 (Fig. 8) showed the stomach high and regular with active peristalsis. The cap was constantly irregular but with no spasm or retention.

The patient has had no return of symptoms up to the present time.

CASE IX. (Dr. R. W. Bolling.) W. B., male,

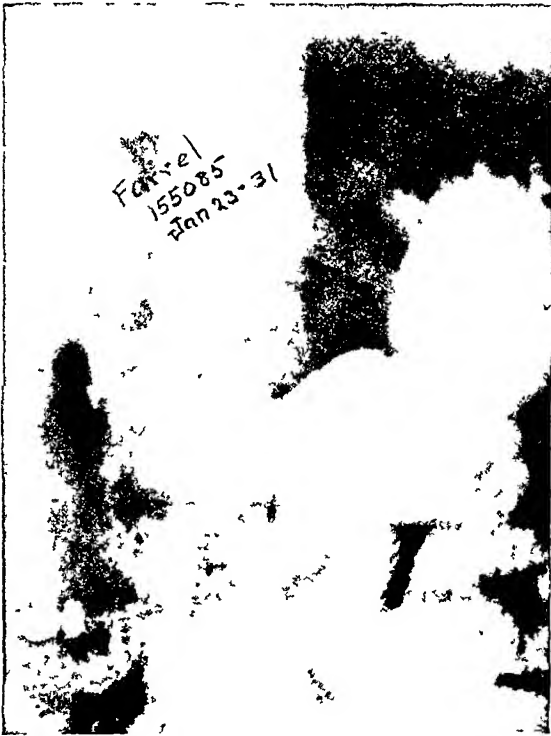


FIG. 8. Case VIII, seven years and ten months post-operative. Irregularity of cap was constant. No symptoms since operation.

aged fifty-seven, was admitted on December 29, 1923. Two hours before he had had a sudden severe sharp pain in the epigastrium with nausea but no vomiting. For two weeks he had had epigastric discomfort every day about 5 P. M. Examination showed generalized board-like rigidity which was most marked in the right upper quadrant.

Immediate operation revealed a considerable amount of bile-stained fluid in the peritoneal cavity. On the anterior surface of the first portion of the duodenum just distal to the pylorus was a 2 mm. perforation surrounded by only a moderate amount of induration. The perforation was inverted and the wound drained only down to the peritoneum.

Convalescence was uneventful and the patient was discharged without symptoms on January 20, 1924.

Postoperative roentgen ray examination on February 10, 1927, showed a sac in close relation to the duodenal cap which retained barium for twenty-four hours. This could have been a dilata-

tion of the second portion of the duodenum. The cap filled fairly well.

Another study on January 22, 1931 (Fig. 9) showed a large stomach lying quite low. There was a pocketing of barium in the second portion of the duodenum which retained barium at the end of 6 hours (Fig. 10). This could be a diverticulum.

He has had no symptoms other than a moderate grade of constipation since the operation.

CASE X. (Dr. F. W. Solley.) J. D., male, aged twenty-two, was admitted on June 22, 1926. One hour before admission he had had a sharp sudden severe pain about the umbilicus without vomiting. For the two weeks preceding he had had epigastric pain one to two hours after meals with vomiting. Examination showed board-like rigidity, most marked in the upper abdomen.

Immediate operation revealed only a small amount of fluid in the peritoneal cavity. On the anterior surface of the duodenum, just distal to the pylorus was an indurated area 3 cm. in diameter with a 5 mm. perforation in its center. The perforation was inverted. No drainage was used.

Convalescence was complicated by bronchopneumonia but the patient left the hospital on July 9, 1926, without symptoms.

Three months later he returned with a recurrence of the ulcer symptoms.

Postoperative roentgen ray examination on September 28, 1926, showed a small amount of gastric retention. There was slow emptying through the duodenum and jejunum. About the duodenum were evidences of adhesions and it did not fill evenly.

The patient continued to have symptoms, which were relieved by ulcer management, to the time last seen about a year after the operation.

CASE XI. (Dr. R. W. Bolling.) C. H., male, aged twenty-eight, was admitted on July 1, 1922. Two days before he had had an acute sudden pain in the right upper quadrant radiating to the back and right shoulder. He vomited. The pain continued to the time of admission. One year previously he had had pain in the epigastrium one to two hours after meals relieved by soda. Examination revealed marked generalized rigidity particularly in the right upper quadrant.

Roentgenographic examination of the abdomen showed no gas bubbles.

Operation was deferred to July 3, 1922, when

January 29, 1922. Six hours before admission he had had a sudden severe stabbing pain over the entire abdomen and had vomited



FIG. 9. Case ix, seven years postoperative to simple inversion of perforation just beyond pyloric ring. Pocket of barium shows beyond cap. This was a constant finding. No symptoms since operation.

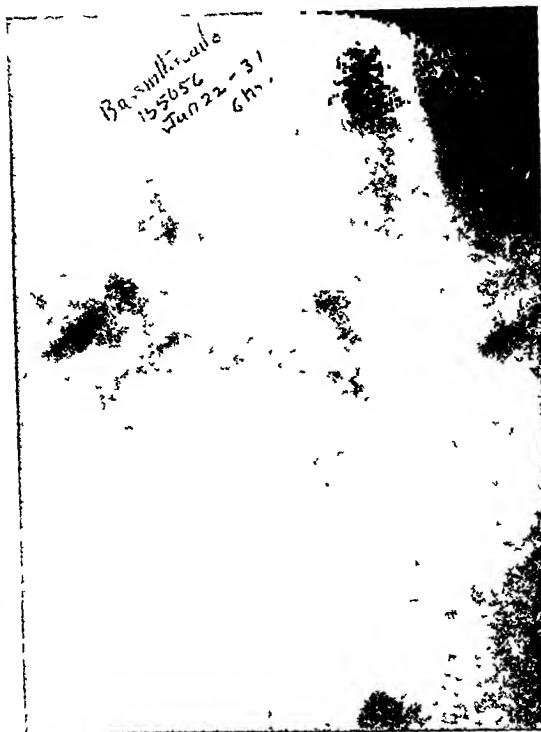


FIG. 10. Six hours after Fig. 9 (Case ix). Barium still present in pocket noted in Fig. 9. This is probably a false diverticulum. No symptoms since operation.

it revealed the omentum plastered over the gall bladder and pyloric regions. The gall bladder was normal except for the fresh adhesions. On the anterior surface of the first portion of the duodenum 3 cm. beyond the pylorus was a 3 mm. perforation about which there was very little induration. The perforation was inverted and a drain inserted down to the fascia only.

Convalescence was uneventful and the patient was discharged on July 22, 1922, without symptoms.

Postoperative roentgen ray examination on January 17, 1923, showed irregularity of the cap but no retention. The stomach was normal.

Another examination on January 8, 1928, showed a persistently irregular cap. The stomach was normal and there was no retention.

The patient has had no return of symptoms up to the present time.

CASE XII. (Dr. R. W. Bolling.) D. K., male, aged twenty-eight, was admitted on

bloody fluid. Eight hours before this attack he had had a fairly severe attack of pain which was relieved by soda. For several years he had had epigastric pain forty-five minutes after meals relieved by soda or food, and during that time he had noticed tarry stools. Examination showed board-like rigidity of the abdomen particularly in the right upper quadrant.

Immediate operation revealed a moderate amount of free gas and fluid in the peritoneal cavity. On the anterior surface of the first portion of the duodenum 4 cm. beyond the pyloric vein was a 3 mm. perforation. This was inverted and the peritoneal cavity drained.

Convalescence was uneventful and the patient was discharged without symptoms on February 16, 1922.

Postoperative roentgen ray examination on January 17, 1924, showed a large stomach with a constant duodenal deformity but no retention.

Another examination on March 6, 1925 showed a constant duodenal deformity without retention.

The patient had had no symptoms except slight indigestion immediately after heavy drinking bouts up to the time last seen in 1928.

CASE XIII. (Dr. R. W. Bolling.) W. McD., male, aged forty-two, was admitted on February 24, 1927, because of a bleeding duodenal ulcer with considerable severe pain in the right upper quadrant. For one year he had had epigastric distress two to four hours after meals with nearly constant pain in the right upper quadrant which was relieved by vomiting. On the third day in the hospital he had a sudden sharp severe pain in the epigastrium and developed board-like rigidity and vomiting.

Immediate operation revealed a moderate amount of bile-stained fluid in the peritoneal cavity. The gall bladder was bound down to the first portion of the duodenum by dense firm adhesions. At this point was a large area of induration with a 7 mm. perforation partly closed by the gall bladder. Closure was completed by a combination of inversion and covering over with the gall bladder. A posterior gastroenterostomy was done and a rubber dam drain inserted down to the fascia.

Convalescence was uneventful and the patient was discharged on March 18, 1927, without symptoms.

Postoperative roentgen ray examination on October 5, 1928, showed rapid and complete emptying through the gastroenterostomy with a very narrow irregular duodenum.

He has had no return of symptoms up to the present time.

CASE XIV. (Dr. R. W. Bolling.) C. P., male, aged forty-five, was admitted on August 27, 1919. One hour before he had had an intense sudden epigastric pain with distention of the abdomen. For three weeks he had had pain in the epigastrium one hour after meals. He vomited with the present attack. Examination showed board-like rigidity, generalized tenderness and the liver dulness obliterated.

Immediate operation revealed considerable fluid and gas in the peritoneal cavity. Three centimeters beyond the pyloric ring on the anterior surface of the duodenum was a 1.5 cm. area of induration with a 2 mm. perforation. The perforation was inverted and a drain inserted down to the peritoneum.

Convalescence was uneventful and the patient was discharged on September 14, 1919, without symptoms.

Postoperative roentgen ray examination on January 25, 1923, showed normal emptying but the cap was not outlined.

Up to the time he was last seen in June 1926, he had had no return of symptoms.

CASE XV. (Dr. E. D. Truesdell.) J. T., male, aged thirty-three, was admitted December 12, 1923. Two days before he had had a sudden severe pain in the epigastrium. The pain continued and he had vomited. For two years he had had epigastric pain several hours after meals relieved by food. Examination showed a very rigid tender abdomen. Liver dulness was present but there was shifting dulness in the flanks.

Immediate operation revealed a large amount of bile-stained fluid in the peritoneal cavity. Near the lesser curvature 5 cm. above the pylorus was a 5 mm. perforation. This was inverted and a tab of omentum brought across the suture line. A soft rubber dam drain was inserted.

Convalescence was uneventful.

On January 1, 1924 a roentgenographic examination was made outside of the hospital and diagnosed duodenal ulcer.

He was readmitted on February 3, 1924. Roentgenograms of the chest showed pulmonary tuberculosis and the sputum was positive.

Postoperative roentgen ray examination on February 5, 1924, showed active peristalsis and no six hour retention. The duodenal cap was constantly deformed.

The patient was discharged on February 12, 1924, on ulcer treatment and management of the pulmonary tuberculosis.

On September 15, 1924 he was readmitted because of continued ulcer symptoms and pulmonary and laryngeal tuberculosis.

Postoperative roentgen ray examination on September 20, 1924, showed hyperperistalsis. There was a definite and constant defect in the cap.

He was discharged September 22, 1924, and continued to be troubled by gas after meals.

He died of the tuberculosis on September 27, 1928.

EXCISION AND PYLOROPLASTY

CASE XVI. (Dr. J. Douglas.) M. McM., male, aged thirty-six, was admitted on October 15, 1924. Six days before he had had a sudden severe pain in the upper abdomen. Examination showed marked rigidity of the right upper rectus with a tender mass in this region. He

was watched for nine days with a diagnosis of acute cholecystitis.

Operation on October 24, 1924, revealed a well walled-off abscess between the liver, gall bladder, colon and duodenum. On the anterior superior aspect of the first portion of the duodenum was a perforation surrounded by a moderate amount of induration. In the abscess cavity were about 2 oz. of pus. The ulcer was excised and a Horsley pyloroplasty done.

Convalescence was uneventful and the patient left the hospital on November 19, 1924 without symptoms.

Postoperative roentgen ray examination on November 19, 1924, showed a stomach with normal motility. It emptied normally. About the pylorus and cap regions was slight but persistent irregularity.

He has had no return of symptoms up to the present time.

PERFORATION AFTER PREVIOUS EXCISION

CASE XVII. (Dr. F. S. Mathews.) M. P., male, aged fifty-four, was admitted September 14, 1924, because of severe abdominal pain of twenty-four hours duration. He had vomited blood and had noticed tarry stools. For the three weeks preceding he had had severe pain in the right side of the abdomen not related to meals. Beginning five years before admission he had had intermittent attacks of epigastric pain after meals which was relieved by soda or food. Eighteen months before admission he had been operated upon at another hospital with a diagnosis of gastric ulcer. The stomach and gall bladder were reported normal and an appendectomy done. This had given no relief. Examination showed a tender rigid epigastrium with a marked anemia. A transfusion was done and the patient was transferred to surgery.

Operation was done on September 29, 1924. A large ulcer was found with a large crater at about the middle of the lesser curvature with a moderate amount of induration. The gall bladder was edematous and contained several faceted stones. It was subacutely inflamed. The ulcer was excised, a cholecystectomy done and the cystic duct drained. A transfusion was given before the patient left the table.

Convalescence was uneventful except for a "sour stomach" and epigastric discomfort

relieved by soda and hyperacidity diet. The patient was discharged on October 26, 1924.

Postoperative roentgen ray examination on

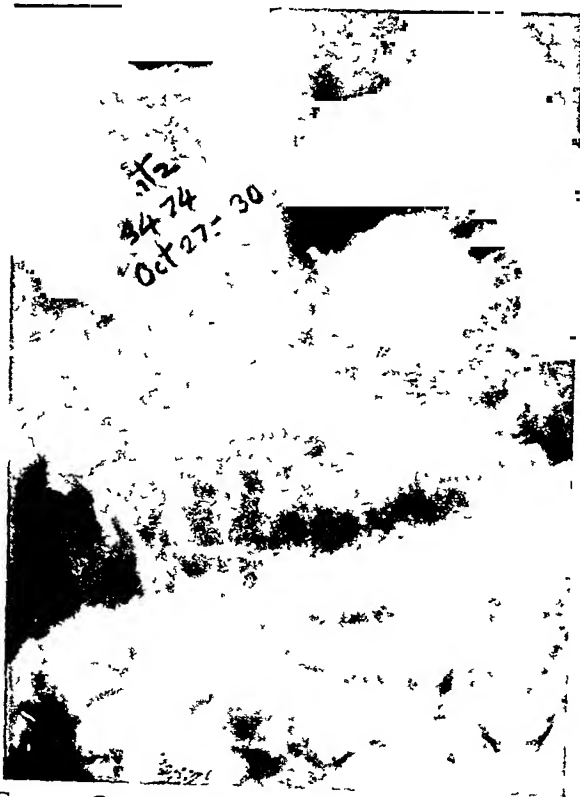


FIG. 11. Case XVII, five years and eight months post-operative to excision and posterior gastroenterostomy for perforation high on lesser curvature. Constant hourglass deformity showed at site of gastroenterostomy. No symptoms since operation.

November 3, 1924, showed an hourglass stomach with definite irregularity at the site of the old ulcer. There was considerable six hour residue.

After operation he continued to have epigastric distress and burning eructations which were improved by ulcer treatment. Because of continued pain he was readmitted on March 24, 1925.

Roentgen ray examination on March 26, 1925, showed no hourglass deformity. The lesser curvature contained a sharply defined semi-circular projection. The cap did not fill out well. There was considerable six hour retention.

Operation on March 30, 1925, revealed a large indurated thick walled ulcer high up on the lesser curvature. It was adherent to the under surface of the liver with a 1 cm. perforation in its center opening into a cavity, the walls of which were made up by the liver.

The ulcer was excised, a posterior gastroenterostomy done and the abdomen closed without drainage.



FIG. 12. Case XVIII, eight years and ten months after a Pólya resection for perforation of first part of duodenum. No symptoms since operation.

Convalescence was uneventful and the patient was discharged without symptoms on April 17, 1925.

Postoperative roentgen ray examination on April 16, 1925, showed a small residue at six hours distal to the gastroenterostomy opening. The ulcer was not mentioned as showing.

In 1926 he was operated upon for fistula in ano, but had had no gastric symptoms.

Postoperative roentgen ray examination on October 27, 1930 (Fig. 11), showed a considerable bourglass deformity at the site of the gastroenterostomy. Emptying was rapid. No evidence of active ulceration was noted.

The patient has had no return of symptoms since the last operation up to the present time.

OLD PERFORATIONS

CASE XVIII. (Dr. W. A. Downes.) A. A., female, aged thirty-nine, was admitted on December 17, 1921, because of "coffee-ground" vomitus for the three preceding days. For eighteen months she had had epigastric pain fifteen to thirty minutes after meals relieved

by soda or induced vomiting. She had vomited food eaten at considerable periods previously. Examination showed only a slight tenderness and rigidity in the epigastrium.

Roentgen ray examination three months before admission was reported gastropnoia only. Another on December 27, 1921, showed an extreme grade of dilatation of the stomach suggestive of pyloric stenosis. It emptied slowly but there was no six hour residue.

On ulcer treatment the pain in the epigastrium became gradually more severe and continuous.

Roentgen ray examination on January 15, 1922, showed the stomach still markedly dilated. There was irregularity about the pyloric end of the stomach and beside the first portion of the duodenum was a pouch-like structure which filled with barium. The pyloric end of the stomach was unusually far to the right. This had the appearance of a perforated ulcer.

Operation on January 18, 1922, revealed dense perigastric adhesions near the pylorus. The duodenum was large and dilated. On the posterior surface of the first portion of the duodenum was an indurated ulcer with a central perforation and a rather large cavity in the pancreas. A Pólya resection was done and the abdomen drained at McBurney's point.

Convalescence was uneventful and the patient was discharged symptom-free on February 4, 1922.

Postoperative roentgen ray examination on February 24, 1922, showed the stomach almost entirely to the left of the midline. The lower portion showed some irregularity. Emptying occurred at a fair rate and there was only very little retention at five hours.

Postoperative roentgen ray examination on November 17, 1930 (Fig. 12), showed some deformity along the great curvature with the stomach situated on the left side of the abdomen. It emptied readily through the gastroenterostomy.

The patient had no return of symptoms to the present time.

CASE XIX. (Dr. W. A. Downes.) W. C. D., male, aged thirty-six, was admitted on September 11, 1925, because of pain in the epigastrium and vomiting several hours after meals. He had had a chancre and salvarsan treatment in 1911. On his admission his Wassermann reaction was reported plus-minus with the cholesterol antigen and negative

with the acetone antigen. Examination showed only moderate tenderness and rigidity in the epigastrium.

Roentgen ray examination on September 15, 1925, showed a rather prominent niche at the edge of the lesser curvature, just above the pylorus.

Operation on September 25, 1925, revealed on the anterior surface of the duodenum just beyond the pylorus a reddened and thickened area 2.5 cm. in diameter. Opposite this on the posterior wall was a large ulcer which had perforated into the pancreas. The pancreas was markedly indurated about the cavity.

The ulcer bed in the pancreas and the edges of the perforation were cauterized. The perforation was closed with chromic sutures. The incision in the anterior wall of the duodenum was closed in the usual manner. A short-loop posterior gastroenterostomy and an appendectomy were then done.

Convalescence was uneventful and the patient was discharged without symptoms on October 7, 1925.

Postoperative roentgen ray examination on November 10, 1930 (Fig. 13) showed a stomach which filled readily. The cap was constantly irregular. The stomach emptied readily through the gastroenterostomy and at six hours there was no retention.

He has had no return of symptoms up to the present time.

CASE XX. (Dr. W. A. Downes.) H. H., male, aged fifty-five, was admitted on September 25, 1922, because of pain and pressure in the epigastrium which began suddenly five days before admission. He had vomited five to six times daily a "coffee-ground" material. The first similar attack had occurred three years before and he had had six in the intervening time. For fifteen years he had had indigestion with epigastric pain two hours after meals, relieved by food or soda. Examination showed considerable tenderness and rigidity of the upper rectus muscles.

Roentgen ray examination on September 27, 1922, showed the lungs negative. In the prepyloric region was a filling defect with a pouch-like projection from the stomach. The stomach emptied in six hours.

This examination was repeated on September 29, 1922, and the same condition was found.

Operation on October 6, 1922, revealed the anterior surface of the stomach adherent to the abdominal wall by dense fibrous adhesions.

On the anterior surface of the stomach just above the pylorus was a healed ulcer. In the middle of the lesser curvature was a perforated

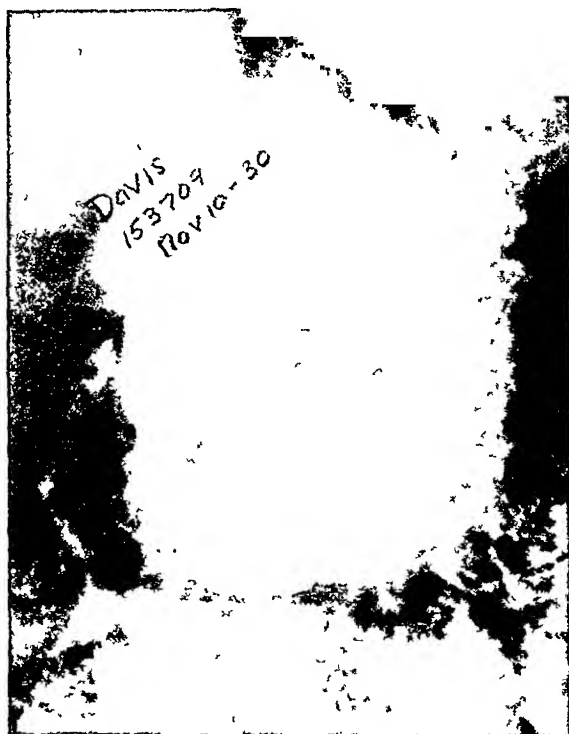


FIG. 13. Case XIX, five years postoperative to cauterization and closure of perforation of first part of duodenum, and posterior gastroenterostomy. Irregularity of cap was constant. No symptoms since operation.

ulcer with a cavity extending toward the tail of the pancreas. The perforation was inverted and a posterior gastroenterostomy done.

Convalescence was uneventful and the patient left the hospital on October 25, 1922, without symptoms.

On October 30, 1925, he returned because of continuous epigastric pain. He had been entirely symptom-free in the interim.

Examination showed an orange-sized mass in the epigastrium.

Roentgen ray examination on November 9, 1925, showed a large filling defect in the lower end of the stomach to which the jejunum was attached. This was diagnosed gastric carcinoma.

He died on November 28, 1925 but no autopsy was obtained. This is the only case in this series among those followed up which has developed carcinoma.

INVERSION AND GASTROENTEROSTOMY

CASE XXI. (Dr. E. D. Truesdell.) B. F. B., male, aged forty-two, was admitted September

17, 1918, because of pain in the right lower quadrant. It had begun suddenly twelve hours previously with vomiting. For ten

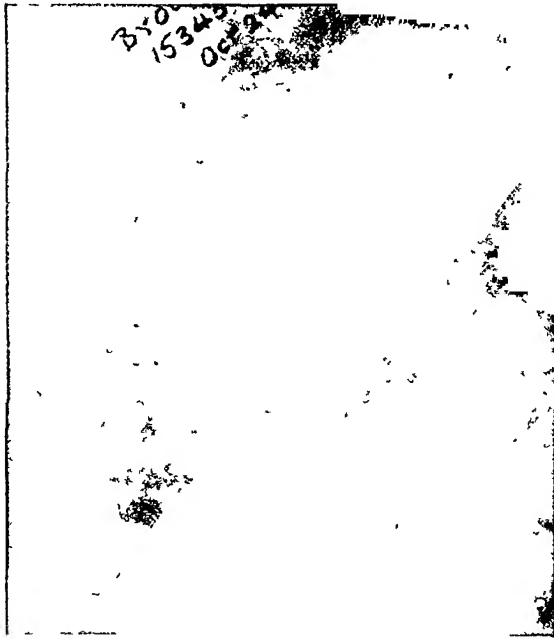


FIG. 14. Case XXI, twelve years postoperative to simple inversion of perforation on stomach side of pylorus with posterior gastroenterostomy. Irregularity which shows in cap was not constant. It filled under fluoroscope. No symptoms since operation.

years he had had pain in the epigastrium one-half hour after meals which was relieved by food. Examination showed marked generalized board-like rigidity.

Immediate operation revealed an abscess cavity over the pylorus made up of omentum and stomach wall. On the anterior surface of the stomach near the pylorus was an ulcer with a perforation in its center. This was inverted and a posterior gastroenterostomy done.

Convalescence was uneventful. He was discharged without symptoms on September 25, 1918.

Postoperative roentgen ray examination on October 24, 1930 (Fig. 14) showed the gastroenterostomy functioning. There was some emptying through the duodenum but no evidence as to the site of the old ulcer.

The patient has had no return of symptoms up to the present time.

CASE XXII. (Dr. M. K. Smith.) A. Z., male, aged eighteen, was admitted on May 12, 1925. Twenty-four hours previously he had

had a sudden severe pain in the right lower quadrant. For years he had had intermittent "stomach aches" every three to four months and lasting a few hours. For the two weeks preceding admission he had had an attack daily.

Examination showed board-like rigidity particularly in the right upper quadrant and epigastrium. Liver dulness was present.

Immediate operation revealed a small amount of purulent appearing fluid in the peritoneal cavity. About the pylorus was a heavy deposit of fibrin. There was an indurated area in the first portion of the duodenum but it was not exposed as it was thought to be sealed off. A posterior gastroenterostomy was done and the peritoneal cavity drained.

Convalescence was complicated by a duodenal fistula which healed spontaneously. Immediately postoperative there was a massive collapse of the right lung from which recovery was complete. On June 13, 1925, he was discharged without symptoms.

Postoperative roentgen ray examination on November 12, 1930 (Fig. 15), showed no evidence of the site of the perforation. The stomach emptied rapidly through the gastroenterostomy.

The patient has had no recurrence of symptoms up to the present time.

CASE XXIII. (Dr. R. W. Bolling.) H. S., male, aged thirty-seven, was admitted on April 2, 1923. He had had pain in the epigastrium and vomiting for ten years. The pain occurred a few hours after meals and was relieved by vomiting or soda. The vomitus often contained food eaten the day before. He had been on bismuth and alkalis for six years. Examination showed tenderness below the ensiform and large peristaltic waves.

On April 4, 1923, he had a sudden severe sharp epigastric pain. His abdomen developed board-like rigidity.

Operation three hours after the onset revealed a large amount of dark brown watery fluid in the peritoneal cavity. On the upper surface of the duodenum near the pylorus was a large area of induration and scarring in the center of which was a 1 cm. perforation. The pylorus was almost completely obstructed. The perforation was inverted and a tab of omentum drawn over the suture line. A posterior gastroenterostomy was done and a drain inserted to the peritoneum only.

Convalescence was uneventful and the patient left the hospital on April 22, 1923, without symptoms.

had had severe attacks of pain relieved by vomiting. Examination revealed tenderness and board-like rigidity especially in the right

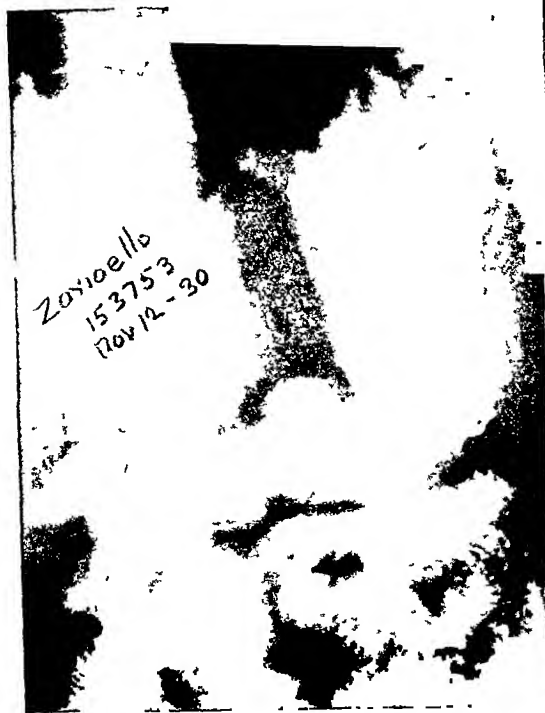


FIG. 15. Case XXII, five years and six months postoperative to posterior gastroenterostomy for perforation of first part of duodenum. Perforation was thought to be sealed by adhesions, but duodenal fistula developed which closed spontaneously. Cap was regular under fluoroscopic examination. No symptoms since operation.

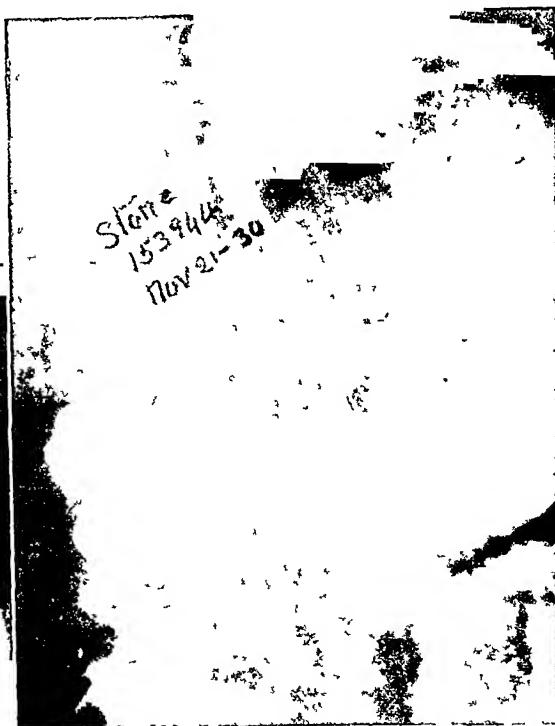


FIG. 16. Case XXIII, seven years and eight months postoperative to simple inversion of perforation just beyond pyloric ring with posterior gastroenterostomy. Cap was regular in outline under fluoroscope. No symptoms since operation.

Postoperative roentgen ray examination on April 25, 1923, showed a large stomach which emptied at the normal rate through the gastroenterostomy opening. There was no retention. No mention was made of the duodenum.

Another on November 21, 1930, (Fig. 16) showed no evidence of the site of the perforation. The stomach emptied both through the duodenum and gastroenterostomy.

He has had no return of symptoms up to the present time.

CASE XXIV. (Dr. R. W. Bolling.) J. K., male, aged thirty-nine, was admitted on January 7, 1920. Six hours before he had had a sudden severe attack of pain in the entire abdomen. He was nauseated and induced vomiting. For the preceding five weeks he had had attacks of epigastric pain two hours after meals which were partly relieved by soda. Three days and one day before admission he

upper quadrant with obliteration of liver dulness.

Immediate operation revealed a small amount of turbid fluid and considerable gas in the peritoneal cavity. About the pylorus was a considerable deposit of fibrin. On the anterior surface of the first portion of the duodenum was an indurated area 2.5 cm. in diameter with a 4 mm. perforation in its center. This was closed by fibrinous adhesions to adjacent structures which freed readily. The induration gave an obstruction of the pylorus which was nearly complete. The perforation was inverted and a posterior gastroenterostomy done. The peritoneal cavity was drained.

Convalescence was uneventful except for some distress after taking food. He was discharged on January 26, 1920.

He was well for nearly two years when ulcer symptoms returned but were controlled by hyperacidity diet.

Postoperative roentgen ray examination on May 24, 1923, showed a normal stomach which emptied readily. The duodenum was irregular

Six hours before admission he had had a sudden sharp severe pain in the epigastrium. He gave a very indefinite history of indigestion

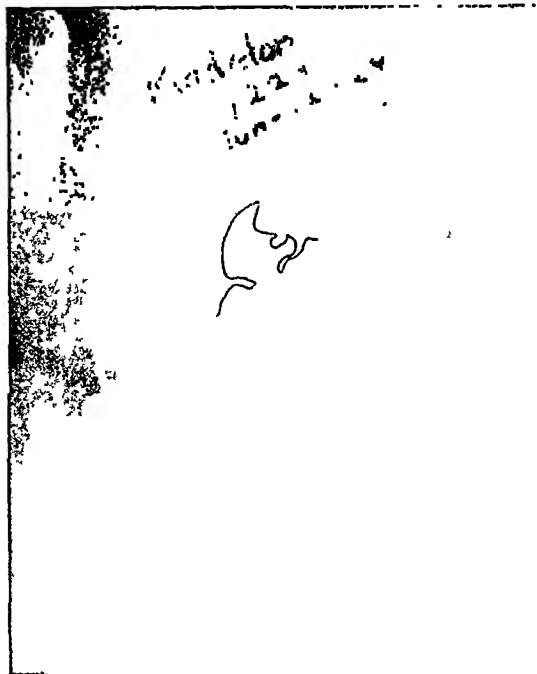


FIG. 17. Case xxiv, nine years and six months postoperative to simple inversion of perforation of first part of duodenum with posterior gastroenterostomy. Defect in cap was constant. No symptoms for five years but had some four years postoperative.

with delay in the ileum. No emptying was visualized through the gastroenterostomy opening.

The symptoms continued but were controlled by alkalis and mineral oil.

Another roentgen ray examination in 1924 showed a normal stomach. The cap did not fill but the stomach emptied at or near the pylorus. The gastroenterostomy opening was not visualized.

Roentgen ray examination on June 12, 1929 (Fig. 17), showed a normal stomach. There was a constant filling defect in the cap. The gastroenterostomy opening was not definitely visualized.

Roentgen ray examination on January 28, 1931 (Fig. 18), showed a normal stomach with active peristalsis. There was narrowing in the region of the cap. Emptying was normal with no six hour retention. Some emptying was noted through the gastroenterostomy.

The patient has had no return of symptoms since 1924.

CASE xxv. (Dr. J. Douglas.) A. C., male, aged forty-one, was admitted on June 1, 1917.

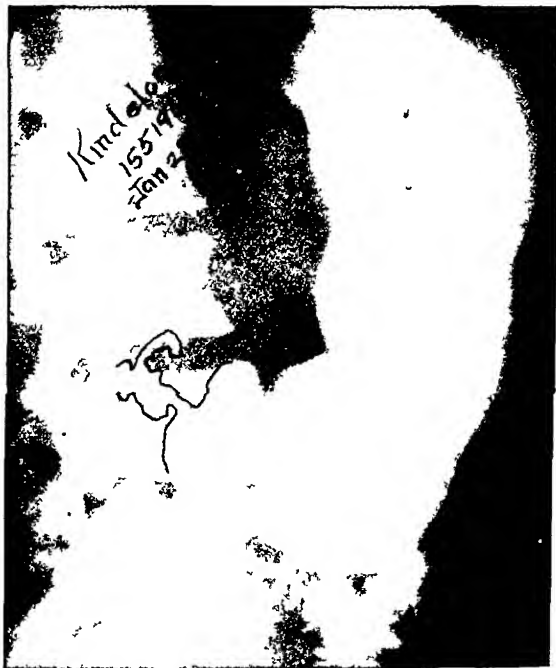


FIG. 18. Case xxiv, eleven years postoperative. Cap was narrowed. No symptoms for seven years.

for years. Examination showed board-like rigidity of the abdomen particularly in the right upper quadrant. The liver dulness was present.

Immediate operation revealed a small amount of bile-stained fluid in the peritoneal cavity. On the anterior surface of the stomach just above the pyloric ring in the center of only a moderate amount of induration was a 2 mm. perforation. The perforation was inverted, a posterior gastroenterostomy done and the peritoneal cavity drained.

Convalescence was uneventful and the patient left the hospital on June 18, 1917, without symptoms.

Postoperative roentgen ray examination on November 21, 1918, showed that the stomach emptied in six hours through the gastroenterostomy. The duodenal cap did not fill.

He has no return of symptoms up to the present time.

CASE xxvi. (Dr. N. Green.) G. K., male, aged sixty-two, was admitted on July 9, 1919. Twelve hours before admission he had had a violent sudden pain in the epigastrium. For

four years he had had epigastric pain four hours after meals. Examination showed board-like rigidity of the abdomen with obliteration of the liver dulness.

Immediate operation revealed a large amount of dark brown fluid and some gas in the peritoneal cavity. On the anterior gastric wall near the pylorus was a perforation surrounded by a large area of induration. The perforation was inverted and a posterior gastroenterostomy done.

Convalescence was complicated by a separation of the wound. A resuture was done on September 11, 1919, and on September 22, 1919, the patient was discharged without any symptoms.

He returned on January 17, 1923, with a papilloma of the bladder and diabetes, but no gastric symptoms. On March 1, 1923, he returned again, this time with carcinoma of the bladder, diabetes and diverticulitis of the sigmoid, but no gastric symptoms.

Postoperative roentgen ray examination on March 5, 1923, showed the stomach emptying rapidly through the gastroenterostomy. The duodenal cap did not fill.

He had no return of gastric symptoms up to the time when last seen on March 14, 1923.

REOPERATED—GASTROENTEROSTOMY

CASE XXVII. (Dr. F. W. Solley.) L. W., male, aged twenty-eight, was admitted on August 11, 1928, because of a sudden sharp pain in the epigastrium two hours before admission. He had had indigestion for three days. Examination showed board-like rigidity of the abdomen.

Operation revealed a 3 mm. perforation on the superior aspect of the first portion of the duodenum in the center of a large area of induration. The abdominal cavity contained a large amount of gastric contents. The perforation was inverted and the abdomen closed without drainage.

Convalescence was uneventful. The patient was discharged August 27, 1928, without symptoms.

He remained well until May 1930, when he began to have slight attacks of pain in the epigastrium radiating to the back. This pain was relieved by food, hot water or milk of magnesia for periods of two to three hours after which it returned. This continued to October 7, 1930, when he reentered the hospital.

On November 10, 1930 (Fig. 19), roentgen ray examination, postoperative to the inversion of the perforation, revealed a large stomach,

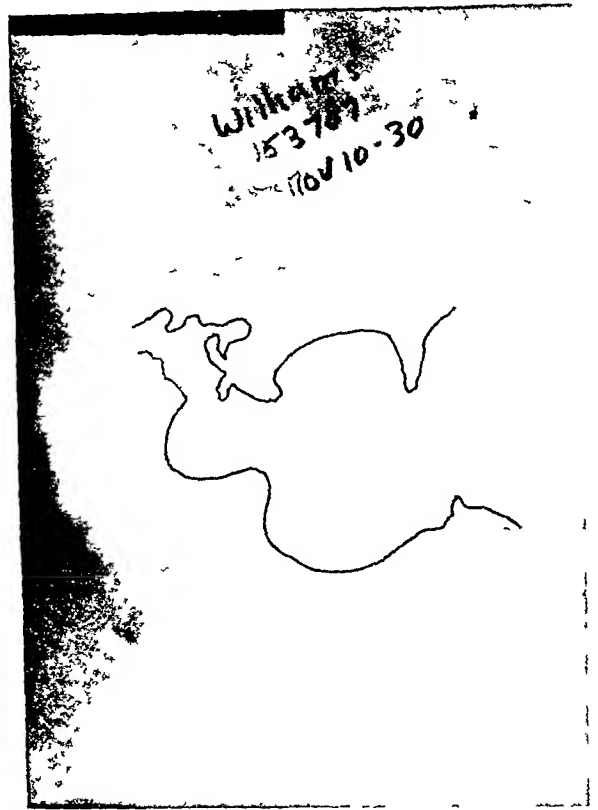


FIG. 19. Case XXVII, two years and three months after simple inversion of perforation in first part of duodenum. Active symptoms for six months preceding this picture. Constant deformity of cap and hyperperistalsis show. Gastroenterostomy gave complete relief from symptoms.

normal in appearance with deep hyperactive peristalsis. The cap filled but showed a constant deformity. There was no six hour retention.

On November 11, 1930, operation revealed a thickened area in the duodenal wall at the old site of the perforation. Evidence of the old suturing could be seen. A second indurated area was felt posterior to this and thought to be a second ulcer. A posterior no-loop gastroenterostomy was done.

Convalescence was uneventful and the patient has had no return of symptoms up to the present time.

CASE XXVIII. (Dr. M. K. Smith.) R. M., male, aged forty-eight, was admitted August 19, 1928. Thirty-six hours previously he had had a sudden severe sharp pain in the epigastrium. He was nauseated but did not vomit. For two years he had been under a physician's

care for gastric ulcer. Examination showed board-like rigidity of the abdomen with obliteration of the liver dulness.

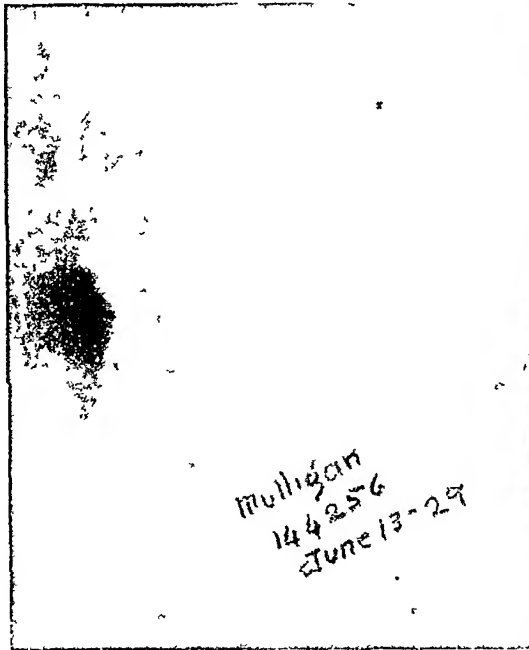


FIG. 20. Case XXVIII, ten months postoperative to simple inversion of perforation just above pylorus. Active symptoms were present for six months preceding this picture. Constant deformity about pylorus and evidences of adhesions to second part of duodenum showed. Gastroenterostomy gave complete relief from symptoms.

Immediate operation revealed a walled-off abscess between the stomach, liver and omentum which contained considerable yellow purulent fluid. Just above the pylorus was a 3 mm. perforation and about it a moderate amount of induration, which was inverted and covered with a tab of omentum. A small bleeding area on the liver was packed with iodoform gauze and a rubber dam drain inserted into the peritoneal cavity.

The wound separated down to the fascia, but healed well by granulation. The patient was discharged without symptoms on September 18, 1928.

The report and films of a roentgen ray examination on November 15, 1928, were lost. The examination had been made because of a return of mild ulcer symptoms.

He was readmitted June 11, 1929, because of epigastric pain with occasional nausea and vomiting of six months' duration. Milk or soda relieved the pain.

Roentgen ray examination on June 13, 1929, (Fig. 20), showed evidence of an old ulcer with pain on pressure over the site of the deformity.

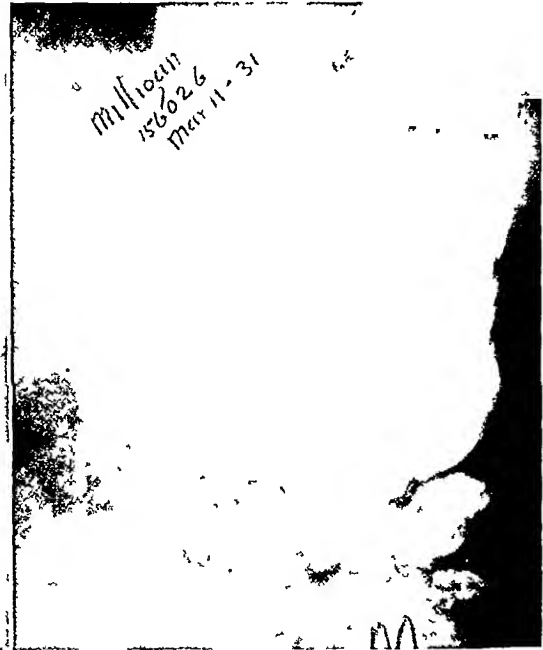


FIG. 21. Case XXVIII, twenty-one months postoperative to posterior gastroenterostomy for recurrence of symptoms with complete relief.

There were evidences of adhesions to the second portion of the duodenum but the stomach was empty at six hours.

Operation on June 15, 1929, revealed the pylorus and first portion of the duodenum firmly adherent to the under surface of the liver. From inside the stomach the old ulcer could be felt but the adhesions were not disturbed. A posterior gastroenterostomy was done.

Convalescence was uneventful. The patient was discharged on July 1, 1929, free of all symptoms.

Postoperative roentgen ray examination on March 11, 1931, (Fig. 21) showed a stomach that filled well and emptied rapidly through the gastroenterostomy. The bulb showed constant irregularity and the remainder of the duodenum was not visualized.

He has had no return of symptoms to the present time.

CASE XXIX. (Dr. E. J. Donovan.) J. J. S., male, aged forty-five, was admitted on April 22, 1929, because of tarry stools. He had had continuous epigastric pain for periods of

several weeks at intervals during the year preceding admission. This pain had no relation to meals. Examination showed a very tender

He returned to the hospital on October 19, 1930, because of a sudden severe epigastric pain three days before admission. This had

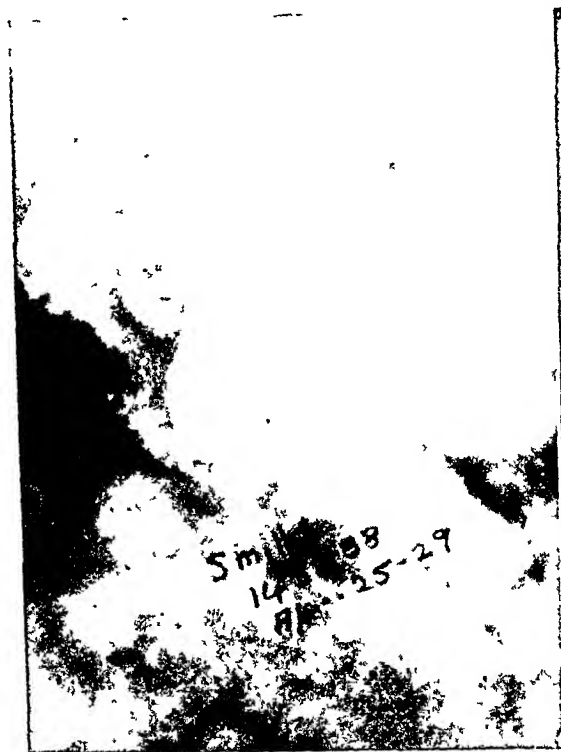


FIG. 22. Preoperative roentgenogram of Case XXIX shows an irregularity of first part of duodenum which was constant. Operation revealed a sealed off recent perforation at this site although a temporary duodenal fistula formed postoperative. No symptoms since operation.

epigastrium with no obliteration of liver dullness.

Roentgen ray examination April 25, 1929 (Fig. 22), revealed a large stomach with a sensitive pylorus. The duodenum was small and irregular. There was no six hour residue.

Operation on May 1, 1929, found a perforation of the first portion of the duodenum with an area of localized peritonitis. The ulcer was inverted and a rubber dam drain inserted into the peritoneal cavity.

Convalescence was stormy. Two transfusions were given. A temporary duodenal fistula formed but closed spontaneously. The patient was discharged June 15, 1929, free of all symptoms.

Postoperative x-ray examination August 1, 1929 (Fig. 23), showed a spastic stomach with spasticity and irregularity of the pylorus and first portion of the duodenum.

In the first sixteen months postoperative, his weight increased from 90 lb. to 140 lb.

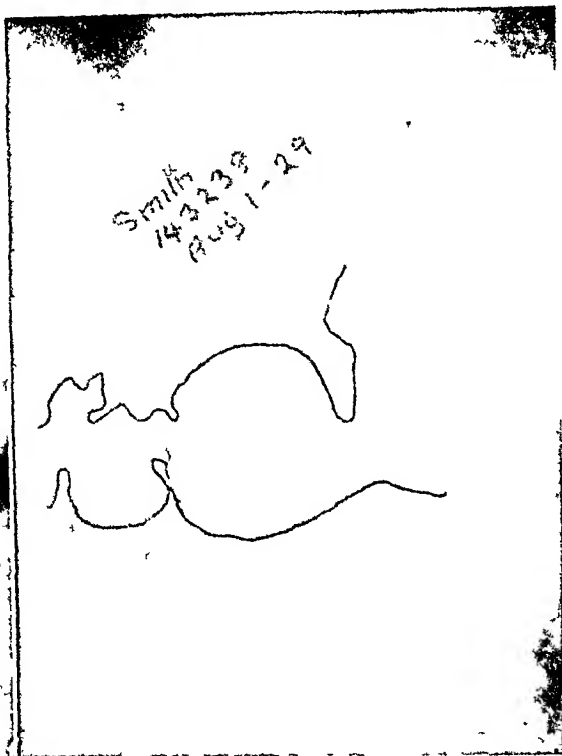


FIG. 23. Case XXIX, three months postoperative to simple inversion of perforation in first part of duodenum. Irregularity in cap was constant. No symptoms since operation.

decreased in severity gradually to the time of admission.

Postoperative x-ray examination on October 20, 1930, (Fig. 24), showed a small active stomach, high in position. The cap filled but was irregular. No spasm or tenderness was noted and there was no six hour retention.

Operation on October 25, 1930, revealed the viscera of the upper abdomen covered with adhesions. The region of the ulcer was not visualized or palpated. A posterior no-loop gastroenterostomy was done.

On November 5, 1930, he began to vomit. On the next day he had a definite intestinal obstruction and a jejunostomy was done and the obstructed mass short circuited by a jejunoileostomy. Convalescence was uneventful. The patient left the hospital on December 2, 1930, without symptoms and has had none to the present time.

CASE XXX. (Dr. R. W. Bolling.) C. A., male, aged twenty-six, was admitted on

December 3, 1926. Nineteen months previously he had had a perforated ulcer of the first portion of the duodenum which was

Convalescence was uneventful and the patient was discharged on December 31, 1926, without symptoms.

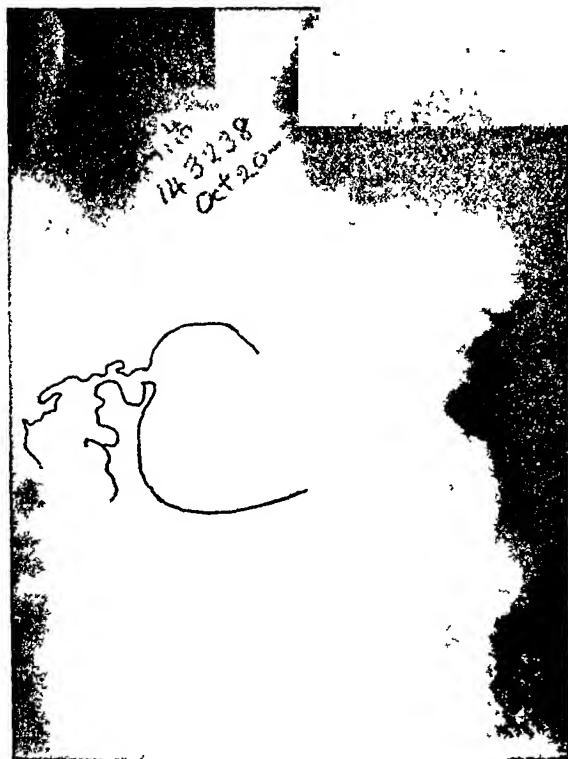


FIG. 24. Case XXIX, eighteen months postoperative. Cap was constantly irregular. Symptoms for three days only before this picture. Gastroenterostomy done with complete relief.

inverted. The peritoneal cavity had been drained. Since the operation he had been unable to eat solid food because of the great epigastric distress it caused. He had had indigestion and epigastric pain not related to meals for ten years.

Roentgen ray examination on December 7, 1926, (nineteen months postoperative) showed a constant incomplete filling defect of the duodenal cap. This had the appearance of active ulceration. The last part of the antrum also showed considerable deformity, due to spasm rather than ulceration. There was no six hour residue in the stomach but a small area in the cap retained barium which was probably the crater of the ulcer.

Operation on December 13, 1926, revealed adhesions over the duodenum with bands to the liver and gall bladder. The appendix was not found. The duodenum was not explored. A posterior gastroenterostomy was done.

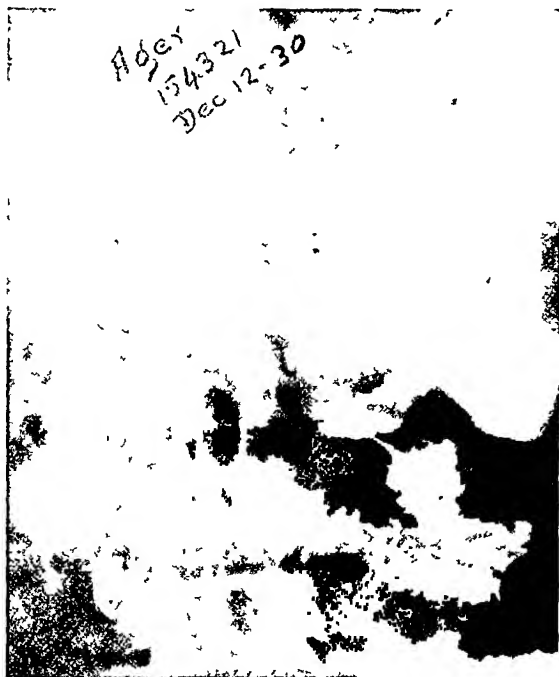


FIG. 25. Case XXX, five years and seven months postoperative to simple inversion of perforation in first part of duodenum and four years postoperative to posterior gastroenterostomy for recurrence of symptoms. Irregularity of cap was not constant. No symptoms since last operation.

On January 26, 1927, he returned for a right indirect inguinal herniorrhaphy. He had no gastric symptoms. In 1928 he had slight indigestion relieved by correction of diet.

Postoperative roentgen ray examination on June 22, 1928, showed good emptying through the gastroenterostomy. There was no definite defect of the pylorus or duodenum.

Another on December 12, 1930 (Fig. 25), showed active function of the gastroenterostomy, with some emptying through the pylorus. There was a markedly deformed cap but no spasm or tenderness. This appeared to be a healed process.

He has had no return of symptoms to the present time.

REOPERATED—SECOND PERFORATION

CASE XXXI. (Drs. F. S. Mathews and A. E. Ada.) L. G., male, aged thirty-six, was admitted on January 28, 1928, because of a sudden severe sharp epigastric pain nine hours before admission. He had had epigastric distress two to

three hours after meals for the preceding three years. Examination showed board-like rigidity of the abdomen.

5 mm. perforation in the center of an indurated area 4 cm. in diameter. There were many adhesions about the duodenum. The perfora-



FIG. 26. Case xxxi, two years and two months postoperative to simple inversion of perforation just beyond pyloric ring, and five months postoperative to simple inversion for reperforation at same site. Perfectly normal stomach and cap showed. No symptoms since second operation.

Immediate operation revealed a "punched-out" perforation surrounded by a moderate amount of induration 1 cm. beyond the pyloric ring on the posterior wall of the duodenum. The abdomen and pelvis were filled with a watery fluid. The perforation was inverted and the abdomen closed without drainage.

Convalescence was uneventful. The patient was discharged without symptoms on February 17, 1928, on a Lenhart diet.

He had no symptoms for eighteen months when he again began to have epigastric distress two to four hours after meals. On December 21, 1929, he was readmitted because of a severe cramp-like pain in the upper abdomen three hours before admission followed by vomiting. Examination showed board-like rigidity of the abdomen.

Immediate operation revealed a large amount of turbid viscid fluid in the abdominal cavity. At the site of the original perforation was a



FIG. 27. Case xxxiii, eleven years after perforation of first part of duodenum was cauterized and inverted and a posterior gastroenterostomy done; four years and four months postoperative to excision of marginal ulcer, undoing of gastroenterostomy and pyloroplasty. Cap was large and constantly deformed. No symptoms since last operation except mild attacks of epigastric distress relieved by soda.

tion was inverted and the abdomen closed without drainage.

The wound opened up, but with no duodenal drainage. It healed well by granulations and the patient was discharged without symptoms on January 30, 1930.

Postoperative roentgen ray examination on May 23, (Fig. 26), showed a small high placed stomach. A large cap filled smoothly and at six hours there was no retention.

He has had no return of symptoms to the present time.

CASE xxxii. (Drs. E. J. Donovan and R. W. Bolling.) G. B., male, aged forty-five, was admitted on April 1, 1925, because of a sudden sharp severe pain in the epigastrium one hour before admission. There was no vomiting or previous history of indigestion. Examination showed moderate rigidity and tenderness in

the epigastrium with complete obliteration of the liver dulness.

Immediate operation revealed an indurated area 2 cm. in diameter on the anterior surface of the second portion of the duodenum in the center of which was a 2 mm. perforation. There was a small amount of bile-stained fluid and a considerable amount of gas in the peritoneal cavity. The perforation was inverted and the abdomen closed without drainage.

Convalescence was complicated by bronchopneumonia and pleurisy with a small amount of effusion in the right chest. The upper angle of the wound was infected and healed by granulation. The patient was discharged free from symptoms on May 10, 1925.

Postoperative x-ray examination October 16, 1925, showed the stomach held up by the transverse colon which was caught in the hernia. The duodenum and the stomach were distended but at six hours there was only slight residue.

He continued symptom-free until April 22, 1926, when he began to have epigastric distress. On April 23, 1926, he was readmitted because of a sudden severe epigastric pain two hours before admission. He had not vomited. Examination showed a hernia in the upper end of the old scar with marked tenderness and rigidity over the entire abdomen.

Immediate operation revealed at the site of the original perforation a 6 mm. perforation in the center of a moderate amount of induration. The abdomen contained only a small amount of fluid. There were many adhesions between the duodenum, the omentum and the abdominal scar. The old scar and hernia were excised, the adhesions freed, and the perforation inverted. Drains were inserted down to the fascia.

Convalescence was uneventful and the patient was discharged symptom-free on May 10, 1926.

Postoperative roentgen ray examination on November 19, 1926, showed a slightly irregular cap. The stomach was hyperactive and contained no six hour residue.

He remained symptom-free to April 1927, since which time he has not been seen.

REOPERATED—MARGINAL ULCER

CASE XXXIII. (Dr. F. S. Mathews.) B. B., male, aged thirty-eight, was admitted on August 28, 1919. He had had epigastric pain

three to four hours after meals for the preceding fifteen years. Blood had been noticed in the stools eight to ten years before admission. Two months before admission he had had a sudden severe attack of epigastric pain requiring morphine for relief. Examination showed some rigidity and tenderness to pressure in the epigastrium.

Roentgen ray examination on August 29, 1919, showed the stomach dilated. There was a persistent deformity and non-filling of the pyloric end of the stomach and first portion of the duodenum. At the end of six hours there was moderate retention.

Operation on September 2, 1919, revealed firm adhesions between the anterior surface of the duodenum and the under surface of the liver. In the center of these adhesions was an abscess cavity communicating with the first portion of the duodenum by a 6 mm. perforation in the center of an old indurated ulcer. This opening was 3 cm. below the pyloric vein. The ulcer was cauterized and inverted. A posterior gastroenterostomy and an appendectomy were then done.

Convalescence was uneventful. The patient was discharged free from symptoms, on September 17, 1919.

Postoperative roentgen ray examination on September 16, 1919, showed a stomach normal in size. The meal passed slowly through the gastroenterostomy opening. It was empty in five hours.

Another postoperative roentgen ray examination was made on May 6, 1921, because of recurring attacks of dull aching pain in the left upper abdomen which was relieved by food. No filling defect was noted in the stomach. The first portion of the duodenum filled incompletely. There was marked delay in the second portion of the duodenum and no mention was made of the gastroenterostomy opening.

The symptoms continued as described to June 21, 1926, when he was readmitted to the hospital.

Roentgen ray examination on June 23, 1926, showed an irregularity of the stomach at the gastroenterostomy stoma. The stomach emptied very slowly through the stoma. These findings were very suggestive of a gastrojejunal ulcer.

Operation on June 26, 1926, revealed the old ulcer well healed with some constriction at the pylorus. There was a fairly large marginal

ulcer. The gastroenterostomy was undone, the ulcer excised and a pyloroplasty performed.

Convalescence was again uneventful. During the four years since he has had attacks of mid-epigastric pain relieved by soda at intervals of about six months.

Postoperative roentgen ray examination on October 7, 1930 (Fig. 27) showed a stomach normal in size and placed high. The cap was large and contained a persistent deformity. There was no spasm or retention. This was not the picture of active ulceration.

He has since been controlled by a hyper-acidity diet but is troubled by mucous colitis. This is the only diagnosed marginal ulcer in the series.

Note. The 82 patients included in this report were operated upon by the various members of the surgical staff of St. Luke's Hospital. It is with their kind permission that they are reported and I wish to take this opportunity of thanking them for their kindness in permitting me to use their cases.

I also wish to express my thanks for the fullest cooperation afforded me by the Follow-up and Roentgen-ray Departments of the hospital force, and to Dr. Eric Ryan, the roentgenologist at St. Luke's Hospital, for the large amount of work involved in checking these cases from a roentgenological point of view.

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[For Remainder of References see p. 320.]

A STUDY OF BLEEDING GASTRIC AND DUODENAL ULCERS

WITH A PLEA FOR EARLY SURGICAL INTERVENTION*

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IT is a common experience to those engaged in the practice of gastroenterology to see patients who are suffering



FIG. 1. Ulcer of duodenum. Arrow points to erosion into pancreaticoduodenal artery.

from gastric or duodenal ulcer, of a type soon to be described, literally bleeding to death under the very eyes of the surgeon and internist who are engaged in an academic controversy regarding the advisability of surgical intervention. The post-mortem examination of these cases reveals the futility of procrastination. There is usually found an extensive ulceration with erosion into a large artery, such as the pancreaticoduodenal, which is the seat of such marked fibrosis as to make spontaneous closure impossible. The following are 2 illustrative cases:

CASE 1. B. G., male, fifty-two years of age, was admitted to the Jewish Hospital of Brooklyn, on the medical service of Dr. S. R. Blatteis, on March 24, 1930, suffering from repeated hematemesis of two days' duration. The onset of his illness dated back to about one year previous to the present attack. At that time he complained of weakness and dizziness. During one of these attacks he fainted. About two months before admission he had a spell of persistent nausea and vomited all food ingested. Several weeks later he had a recurrence of these symptoms. About one month prior to admission he vomited bright red blood and became unconscious for a short time. For the past month he had been complaining of belching, acid eructations, constipation and tenesmus with occasional black stools. The past and family history was irrelevant.

On physical examination the patient was found to be well developed and fairly well nourished but exceedingly pale. The heart sounds were very weak. The blood pressure was 66/45; pulse, 90 per minute, regular, but weak; the temperature was slightly elevated. Abdominal examination revealed resistance to palpation in the region of the epigastrium.

On the day after admission, the patient vomited 6 oz. of bright red blood and passed tarry stools. The hemoglobin determination was 50 per cent (Dare) and the red cell count was 3,750,000 per c.mm. He was given a transfusion of 500 c.c. of unmodified blood to which he responded very well. He felt more comfortable and his general condition was improved. A surgical consultation was had at that time and conservative treatment was advised until the cessation of active bleeding. Soon after this, the patient's condition became worse and another blood transfusion was given, followed by a clysis of 1000 c.c. of a 2 per cent glucose solution. He was somewhat improved and another surgical consultation followed. Further conservative treatment was

* From the Department of Pathology, Dr. Max Lederer, Director, Jewish Hospital of Brooklyn, and from the Hugo Hirsch Foundation for the Study of Gastroenterology. Submitted for publication July 22, 1931.

again advised. On the following day, the third day after admission, the patient made a rapid decline and died.

occasional dizziness. He also noticed that his skin was becoming very pale. The symptoms were growing progressively worse. For some

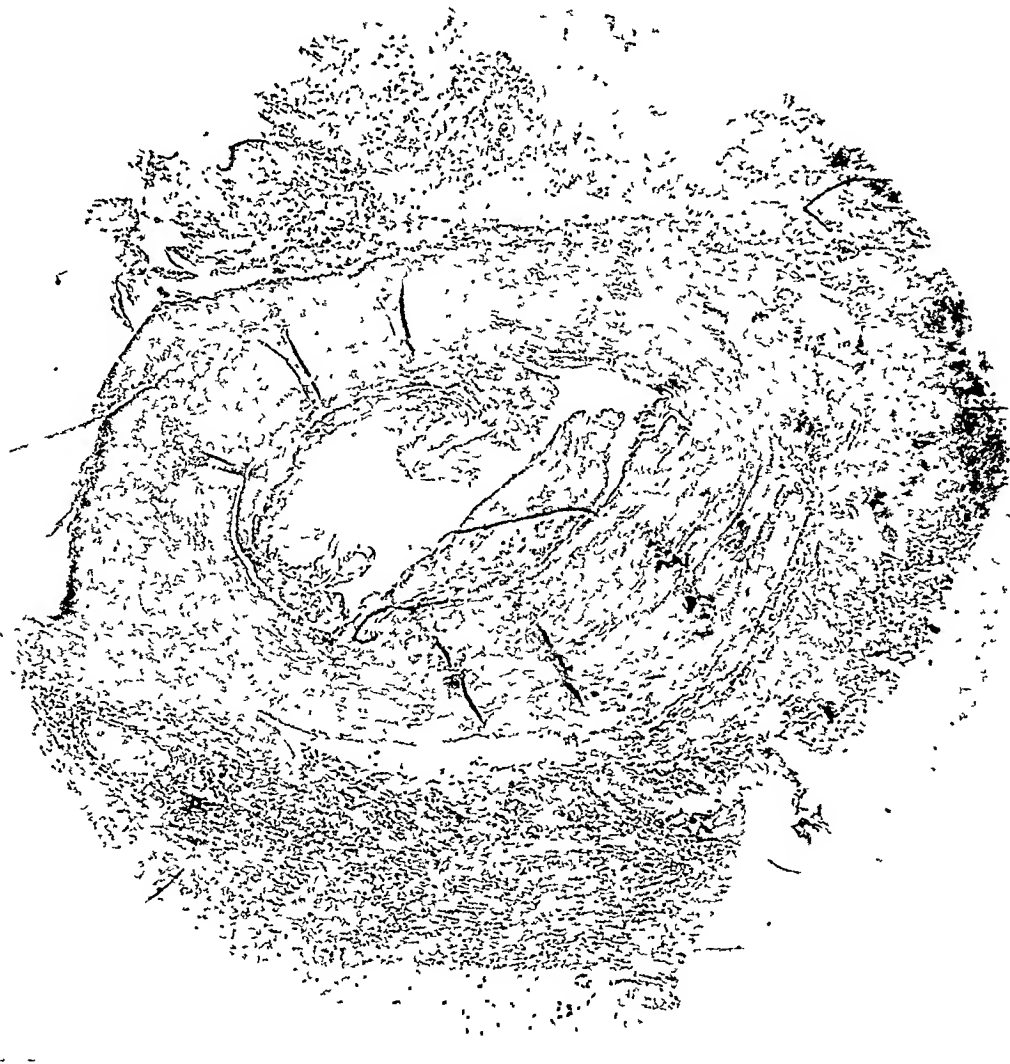


FIG. 2. Transverse section of ulcer through eroded pancreaticoduodenal artery showing marked scarring of vessel wall and fibrosis of perivascular tissue in which the artery is embedded. Note the incomplete thrombus formation in lumen of vessel (low power—hematoxylin and eosin).

CASE II. I. D., male, aged sixty-four, was admitted to the Jewish Hospital of Brooklyn, on January 13, 1931, on the service of Dr. Rabinowitz, complaining of weakness, pallor, palpitation and shortness of breath. About three years previously, he began to experience constant epigastric pains, which, however, were not related to meals. At that time, x-ray studies did not reveal any evidence of gastrointestinal changes. Three weeks before admission he began to complain of extreme weakness even while at rest. This was accompanied by dyspnea on exertion, buzzing in the ears, and

time he had been observing black stools which he ascribed to certain powders which were prescribed for him.

On physical examination he was found to be well developed and fairly well nourished but extremely pale. His blood pressure was 100/60, pulse, 140 per minute, regular, but weak; temperature ranged from 99.9°F to 100.8°F.

A soft systolic murmur was heard over the entire precordium. A rectal examination revealed the presence of tarry stools. Proctoscopic examination and a barium enema revealed no rectal or colonic pathology. The hematological

study revealed a severe grade of secondary anemia. The hemoglobin on admission was 19 per cent (Dare) and remained at about

condition and he died about three weeks after admission. Each time that he lapsed into a state of shock and also just prior to death, he

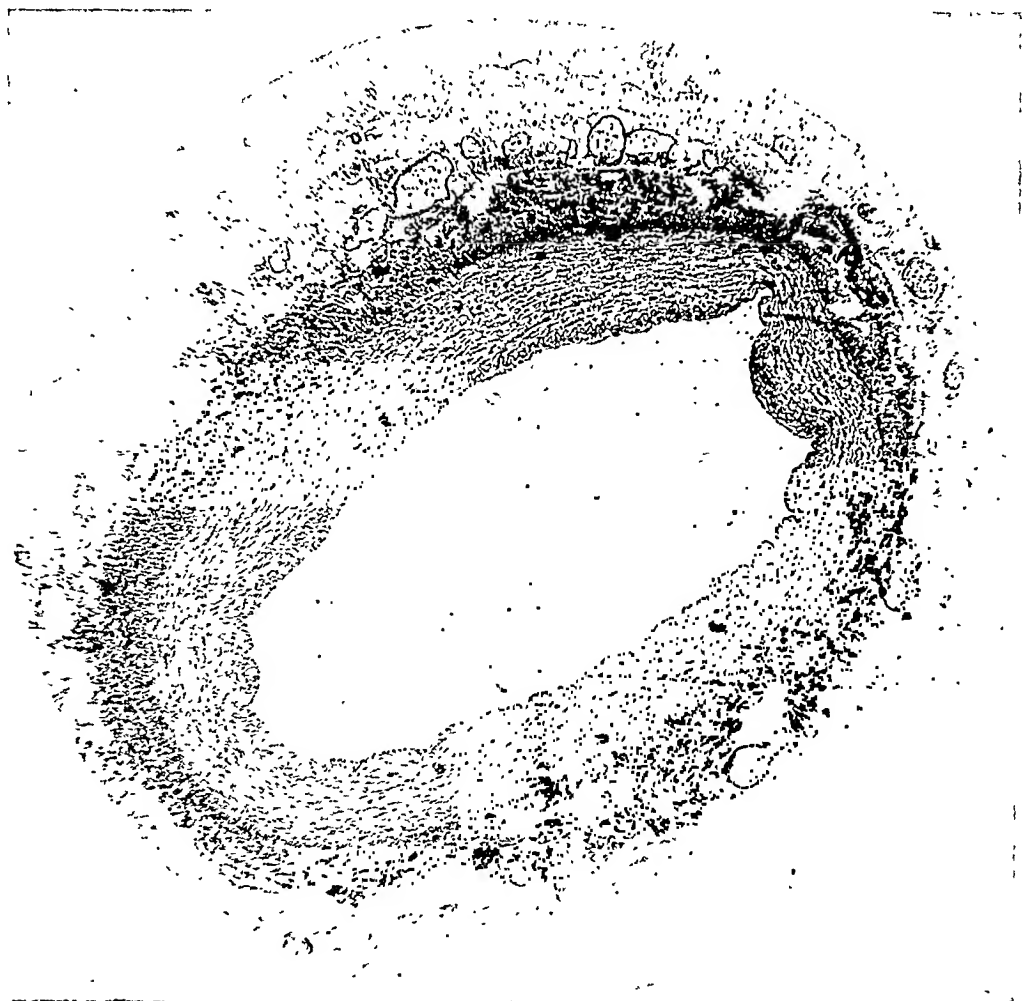


FIG. 2A. Transverse section of a normal pancreaticoduodenal artery of similar caliber as that shown in Fig. 2 and exactly similar location. Note the difference in width of vessel wall as compared to that in Fig. 2.

this level throughout the course of the illness.

As in the previous case, the patient continued to show evidence of massive hemorrhages. There were frequent large, tarry stools. Repeated blood transfusions (a total of about 3000 c.c.) were given, together with liver therapy, in the hope of improving his condition, so as to make him fit for surgical intervention, but without avail. The patient frequently went into a state of shock which was again and again combated by blood transfusion. Although the improvement with transfusion was definite, it was only temporary. Each recurrence left the patient in a more critical

presented the unmistakable picture of air hunger from exsanguination.

POST-MORTEM EXAMINATION

The description of the findings will be limited to the gastrointestinal tract, since the changes in the other systems are irrelevant.

CASE I. Stomach: The organ is filled with fresh blood and its mucosa is hypertrophied.

Duodenum (see Fig. 1): The first portion is filled with blood. Just below the pyloric ring there is an ulcer about 4 cm. in diameter and 1 cm. in depth. The margins are smooth and rounded. The base of the ulcer is scarred and a

large bleeding point can be readily demonstrated (see arrow in Fig. 1). The tissue surrounding this bleeding point is the seat of an scar at the base of and surrounding the ulcer. The lumen of the artery is occupied by a thrombus which is firmly adherent to



FIG. 3. Van Gieson stain of Fig. 2, showing fibrous process involving vessel wall (low power).

extravasation of blood. A definite and large erosion into the pancreaticoduodenal artery is found from which a thrombus protrudes. Near the anterior margin of this large ulcer are found two smaller ones which are more superficial and contain no eroded vessels.

Microscopic examination of a section through the ulcer (Figs. 2, 3, and 4) shows destruction of the mucosa and a marked fibrosis of the wall of the duodenum at the base of the ulcer. The fibrosis extends into the underlying pancreatic tissue. The pancreaticoduodenal artery is also the seat of an extensive fibrosis which involves its entire wall, including the intima. The vessel is embedded in the dense

the intimal lining and which shows beginning organization.

The rest of the intestines are normal except for the presence of a large quantity of clotted blood.

CASE II. *Stomach* (see Fig. 5): The organ contains a large amount of coffee ground fluid. The wall is thickened and the mucosa is hypertrophied.

Duodenum: A large, punched-out ulcer, about 4 cm. in diameter and 1 cm. deep is found in the portion of the duodenum directly over the head of the pancreas. The edges of the ulcer are undermined and its base is

markedly indurated. There is a large communication between the duodenum and the pancreaticoduodenal artery, so that a probe,

erosion presents a most extensive fibrosis of its wall. The elastica of the intimal lining is replaced and destroyed by this fibrous process.

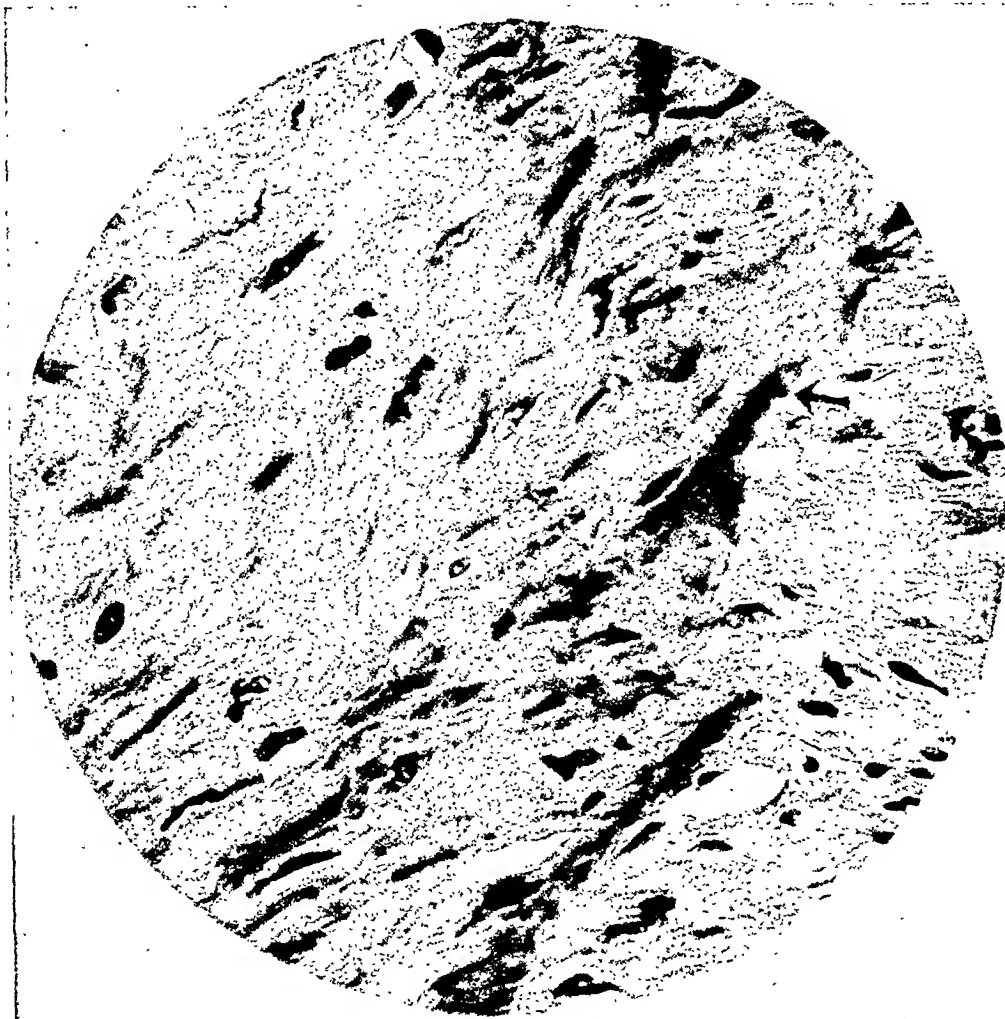


FIG. 4. Van Gieson stain of high power magnification of portion of vessel shown in Fig. 3. Note destruction of elastic fibers by fibrous process. Arrow points to elastic fibers.

the caliber of a matchstick, inserted into the lumen of the proximal cut end of the vessel readily passes into the duodenum. At the site of the erosion the lumen of the vessel is partially occupied by a thrombus which is firmly adherent to the vessel wall (Fig. 6). Two other vessels (veins) which are also eroded stand out prominently in the crater of the ulcer.

Microscopic examination shows a polynuclear cell infiltration in the mucosa and submucosa of the margins of the ulcer. The base of the ulcer is a dense scar which extends to involve the head of the pancreas. The pancreaticoduodenal artery at the site of

The perivascular fibrosis blends with the fibrous process in the wall of the vessel, obscuring the outline of the latter. In the interstices of the vessel wall are found many round cells and plasma cells and a few polynuclear leucocytes. The thrombus in the lumen of the artery is undergoing organization, as noted in the previous case.

The rest of the intestines contain a large amount of clotted blood.

DISCUSSION

In reviewing a series of about 75 clinically proved cases of bleeding gastric or

duodenal ulcers, the writers have found that the cases described here represent a distinct group pathologically and present certain characteristic features clinically: The patient is about fifty years of age or over (females, about a decade younger). Although the past history may not be typical of gastric or duodenal ulcer, there is usually sufficient evidence to suggest the presence of one. The symptoms have persisted for nearly a year or more. There have been recurrent hemorrhages, evidenced either in the form of hematemesis or tarry stools. The continued loss of blood results in a severe anemia which, except for the low color-index, may be mistaken for pernicious anemia. With each massive hemorrhage the patient lapses into a state of shock which can be combated only by blood transfusion.

The massiveness of the hemorrhage indicates an erosion into a large vessel and the favorable effect of transfusion probably indicates that the shock is due to exsanguination. There is a persistent decline in the patient's condition and from the very beginning, one can readily appreciate that no improvement can be hoped for unless the bleeding is controlled. From the nature of the pathological changes, it is quite obvious that it is futile to wait for a spontaneous cessation of the bleeding. The artery which is eroded is of extremely large caliber, and since the erosion is along the longitudinal axis of the vessel, the orifice is quite large. The contractility of the vessel is diminished to a minimum due to fibrous replacement of its wall as well as to the dense perivascular scar of the ulcer in which the artery is embedded, so that spontaneous closure cannot possibly occur. In each of the 2 cases described, a thrombus formed in the eroded portion of the vessel, but it was apparently incompetent to withstand the force of the blood stream.

From these findings it is obvious that the only hope for recovery in this type of case lies in surgical intervention to control the bleeding. However, from a review of the current literature and from the opinions

expressed in personal communications from various surgeons of wide experience, it is apparent that two difficulties are encoun-



FIG. 5. Ulcer of duodenum. Arrow points to erosion into pancreaticoduodenal artery.

tered in the proper management of these cases. One is the difficulty in recognizing any given case as belonging to the group in which the underlying pathology is that of the type of ulcer just described. The other is the poor surgical risk which these patients usually offer for so extensive an operative procedure. As a result, therefore, there seems to be no unanimity of opinion among surgeons as to when intervention is indicated, if at all. Bleeding from peptic ulcers is not always looked upon as a surgical problem. Bevan¹ advises conservative management. Cole² is similarly inclined on the grounds that the same constitutional conditions such as arteriosclerosis, which prevents the healing of ulcers, also makes the patient a poor surgical risk. Pfeiffer³ advised rest, opiates and transfusions.

Many surgeons, however, have realized the need for intervention in bleeding gastric

or duodenal ulcers. Balfour⁴ and Blackburne⁵ both warn against it during the time of bleeding, but firmly believe that

tioned Clendening,⁹ Erdmann,¹⁰ Finney,¹¹ Gowdy,¹² Hartwell,¹³ Jordan,¹⁴ Judd,¹⁵ Lahey,¹⁶ Lewisohn,¹⁷ and Mayo.¹⁸



FIG. 6. Transverse section of ulcer through eroded pancreaticoduodenal artery. Note thrombus and fibrous changes identical with those seen in Fig. 2 of previous case. Arrow points to fibrous adhesion of thrombus to vessel wall, (Low power—hematoxylin and eosin.)

hemorrhage is an indication for surgical intervention. Barton⁶ ascribes some of the surgical failures in these cases to lack of thoroughness in operating. Blackford⁷ advocates resection of the ulcer-bearing area. According to Peco,⁸ small, repeated or minimal and continuous hemorrhages, or the constant presence of occult blood, are all indications for surgical intervention, the operation of choice being resection. Among others who consider bleeding an indication for surgical intervention may be men-

It is not the purpose of the writers to discuss the relative merits of medical and surgical treatment of all types of bleeding peptic ulcer, but rather to point out that from a pathological point of view, the type of case described here cannot possibly yield to any but surgical treatment. The bleeding must be controlled, yet the vascular and perivascular scarring preclude the possibility of spontaneous closure of the eroded vessel, and the only other natural possibility, namely, the occlusion of the vessel

by a spontaneously formed thrombus, is ineffective. There can be but one result—fatal exsanguination. It is to this fact which the authors wish to direct the attention of surgeons who fear the high mortality which this type of case yields if subjected to operation. In view of the existing pathological process in these cases, such an attitude on the part of the surgeon is unjustifiable. Certain it is that the mortality in these cases is high with intervention, but it is also just as certain that the mortality in the particular type of case under discussion is much higher if the patients are not treated surgically. No matter how small a number of cases can be benefited by surgery, it is more than other therapy can accomplish, for nothing but surgical intervention can prevent the inevitable exsanguination.

CONCLUSIONS

1. Two cases of bleeding duodenal ulcer are described with postmortem findings. These cases seem to represent a distinct group pathologically and present certain characteristic features clinically.

2. The outstanding pathological process consists of erosion of the ulcer into a large artery (in the 2 cases described here, the pancreaticoduodenal artery) with fibrosis of the vessel wall and perivascular tissue making spontaneous closure of the vessel impossible. The thrombus which forms in the artery is incompetent to withstand the arterial pressure to prevent bleeding.

3. Due to the nature of the underlying pathology, fatal exsanguination may be prevented only by surgical intervention.

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CHOLECYSTOGRAPHY SIMULTANEOUS WITH THE OPAQUE MEAL*

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CHOLECYSTOGRAPHY may be employed simultaneously in conjunction with the barium meal with

ities as duodenal ulcers irrespective of whether the irregular shape of the filled duodenum was caused by pressure of an

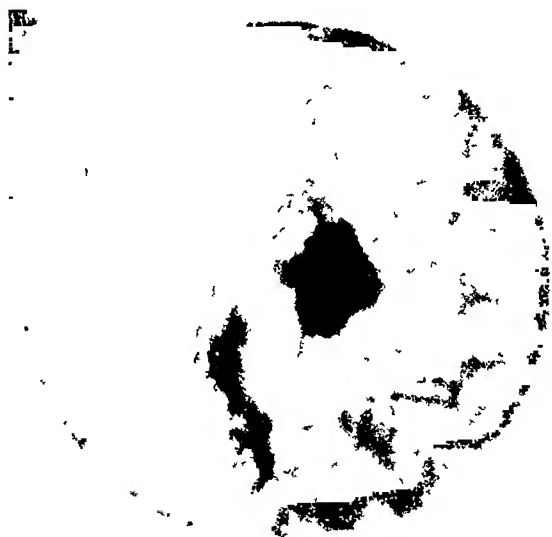


FIG. 1 A. Adhesions between gall bladder and pars descendens duodeni. Note strands of fibers connecting two organs on medial side of gall bladder. There is a distinct impression at lower pole of filled gall bladder. Note angulation of duodenum at place of junction.

satisfactory results. As a routine procedure it is inadvisable; for the ingestion of the barium meal will most often result in the non-appearance or obliteration of the gall-bladder shadow. There is however a certain small proportion of atypical deformities of the duodenal bulb which suggests the diagnosis of an ulcer of the duodenum and yet points to extrinsic conditions of neighboring organs, which cannot be visualized by the use of the opaque meal alone. Since Graham and his co-workers have introduced cholecystography we all have come across bulbar defects which were caused by gall-bladder disease. Up to that time roentgenologists very often diagnosed most bulbar deform-



FIG. 1 B. A drawing which better illustrates Fig. 1 A because entire duodenum is represented as filled.

extrinsic neighboring organ or by an intrinsic crater of the bulb.¹

Today our diagnosis of duodenal ulcer is more accurate, for we have discovered by the use of cholecystography that many irregularities or deformities of the cap which are seen on the film or screen may be the result of pressure or adhesions of the gall bladder or other neighboring organs.

The following 3 cases will perhaps better illustrate the indications for simultaneous cholecystography in conjunction with the barium meal.

CASE 1. Female, thirty-eight years old, complained of pain in the epigastric region for four years. She suffered from fullness and distress one or two hours after meals; was only

¹ Graham, Cole, Copher, Moore. *Diseases of the Gall Bladder*. Phila., Lea & Febiger, 1928, pp. 245-251.

* Submitted for publication May 8, 1931.

relieved by the use of alkalis. Roentgenological examination revealed an irregular and deformed duodenal cap. It was extremely tender to

ning in the direction of the gall bladder. These appeared as small bands and were even more definitely accentuated during screen examina-



FIG. 2 A. Barium meal three hours p.c., stomach partially filled, apex of cap is indistinct; second segment of duodenum dilated.

pressure. Diagnosis: Duodenal ulcer. Advised operation which the patient refused, but she submitted to a strict dietetic regime and other palliative measures. Her condition however did not improve. It was therefore decided to study the biliary tract for the purpose of excluding gall-bladder disease. Cholecystography showed a normally filled gall bladder and failed to reveal any roentgenological evidence of a definite cholecystitis. There was however an extreme tenderness on pressure in this region. But the function of the gall bladder in reference to filling and emptying itself was normal.

Subsequently a compound procedure of cholecystography simultaneous with a barium meal was decided upon for the purpose of determining the origin and cause of the pressure tenderness, for it was obvious that either one or the other of these organs was involved. Examination showed as follows: The stomach was normal in size, shape and contour. The bulb was clearly outlined and visualized. The first segment (pars superior) of the duodenum was more or less deformed at the apex, while the second segment (pars descendens) was visualized and showed band-like shadows run-



FIG. 2 B. Simultaneous cholecystography and barium meal examination. Cap is cut off, gall bladder filled and clearly visualized, adherent to bulb.



FIG. 2 C. Drawing illustrates relation and mode of attachment of gall bladder and apex of duodenum.

tion and revealed tender points on pressure. Furthermore special examination by use of

rubber ball compression proved that it was impossible to separate the second segment of the duodenum from the lower pole of the gall

the gall bladder was drawn towards it. On the other hand if pressure was exerted on the filled gall bladder the duodenum moved in the direc-



FIG. 3 A. Cholecystography, gall bladder filled, slight constriction near lower pole, bent on itself.



FIG. 3 B. Simultaneous cholecystography, stomach properly filled drawn to right, gall bladder visualized, lower pole indenting cap, visualizing a rounded margined shadow, calculus.

bladder. Screen examination definitely showed that if pressure was exerted on the duodenum



FIG. 3 C. Drawing more clearly illustrates deformity of cap caused by calculus within gall bladder.

tion towards it. This explains the symptom complex which appeared in 2 cases. Namely, when the stomach was empty before the examination, the gall bladder was filled with bile and expanded drawing the duodenum towards itself, and giving the patient pain. On the other hand, whenever the stomach was filled the duodenum pulled the gall bladder towards itself giving the patient pain which continued until the stomach more or less emptied itself.

X-ray diagnosis: Adhesions of the gall bladder and the second segment of the duodenum. Operation confirmed the x-ray diagnosis (see Fig. 1 A and 1 B, also Figs. 4 and 5).

CASE II. Mrs. A., forty-five years old, complained of gastric pains for two years; she described them as gnawing and at times burning after meals. There was no vomiting of blood or bloody stools. Roentgen examination revealed the stomach normal in size and shape. There were no niches or other irregularities in the contour of the stomach. Tenderness was localized in the duodenum. The bulb appeared irregular in shape and the apex of the triangle was more or less obliterated. There was a decided gas bubble at the junction of the first and second segment of the duodenum. One hour later the bulb appeared dilated and again irregular in shape and the apex of the bulb was

again obliterated. Under screen examination tenderness on pressure was elicited. Tentative diagnosis: Duodenal ulcer. Subsequently a

plained of fullness and heaviness after meals, nausea and vomiting. Distress was relieved by vomiting. There was a soreness in the region

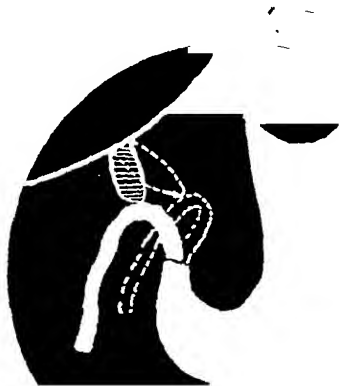


FIG. 4. Mechanism of drawing gall bladder towards duodenum when pressure is exerted on duodenum under screen examination.



FIG. 5. Mechanism of pulling duodenum when pressure is exerted on gall bladder.

compound procedure of cholecystography and barium meal examination was instituted for the purpose of determining the origin and cause of the tenderness in the region of the gall bladder, and particularly to discover the relation of the duodenum and the gall bladder, for while the patient gave a clinical history which pointed towards pathology in the duodenum, no definite roentgenological signs supported the clinical diagnosis. Combined simultaneous examination revealed the stomach normal in size, somewhat drawn to the right. The duodenal cap was quadrangular and the apex appeared to be cut off. The gall bladder was visualized, filled, and clearly outlined. Fluoroscopic examination revealed in this case the similar phenomenon of pain on pressure. The method of compression with the use of the rubber ball failed to separate the gall bladder from the duodenum. The adhesions were practically visualized on the film, for it showed irregular strands of adherent fibers. Further examination by fluoroscope again elicited the phenomenon as described in Case 1, namely, pressure on the gall bladder lifted the bulb upwards, while pressure on the bulb pulled the gall bladder downwards (see Figs. 2 A, 2 B, 2 C. Also Figs 4 and 5).

CASE III. Mrs. S., aged forty-five years, was sent to me for cholecystography. She com-

of the liver. Fruits and fats caused distress. There was a definite history of an attack of colic two or three years prior to this examination. Cholecystography showed the gall bladder clearly outlined with a slight constriction near its lower pole. It seemed to be bent on itself. There was no evidence of calculi and the function of the gall bladder was apparently normal, for it filled and emptied itself without any difficulty (Fig. 3 A).

No definite diagnosis was possible. A combined cholecystography and barium meal were therefore instituted to explain the cause of the constriction of the gall bladder and for the purpose of determining its relation to the duodenum. The stomach was properly filled, somewhat drawn to the right. Its contour was normal, there were no niches, diverticula or incisurae. The duodenal bulb was visualized and showed a rounded indentation caused by pressure of the lower pole of the filled gall bladder. This indentation revealed a margined, rounded calculus, producing the deformity of the duodenal bulb. In this case the simultaneous cholecystography with barium meal examination was the only method which definitely visualized the existence of the calculus (Figs. 3 B and 3 C).

TECHNIQUE

The gall-bladder dye is administered in the usual manner (orally). Twelve, fourteen and sixteen hours after the ingestion of the dye, x-ray films are taken until we find a properly filled and visualized gall bladder. If no diagnosis can be reached and the clinical symptoms are indefinite or point to some disturbance in the stomach or duodenum, a barium meal is immediately administered. This process has the advantage that it fills both the gastrointestinal, and the biliary tract at the same time. The simultaneous visual effect renders it easy and convenient to study the relations of the gall bladder to the duodenum. A diagnosis may be reached in this manner in conditions which are difficult to diagnose when barium meal and cholecystography are separate procedures.

DISCUSSION

These 3 cases illustrate some of the more frequent indications for cholecystography simultaneous with the barium meal examination. In Case 1, the regular gastrointestinal examination together with the clinical signs and symptoms pointed to an ulcer of the duodenum. But a positive diagnosis of adhesions of the gall bladder and the second segment was only made possible after the simultaneously combined method. Ordinarily the roentgenologist cannot always diagnose a case of adhesion of the second segment (pars descendens) of the duodenum because this part is rarely visualized. Of course it should be noted that while the diagnosis of adhesions

is clearly shown by this method of examination, no claim is made that we can determine with this method or any other the nature of the initial lesion which produces the adhesion. Nor can we say with any degree of certainty whether or not the initial lesion which caused the adhesion was in the duodenum or in the gall bladder.

Case II presented similar points of interest with this difference, that the first segment of the duodenum was involved in the adhesion and not the second.

Furthermore the roentgenological and clinical aspect of the case strongly pointed to the location of the lesion in the first part of the duodenum, which was verified by the combined simultaneous examination.

Case III has several points of interest. Clinically the patient gave symptoms of gall-bladder disease. Cholecystography revealed a constriction of the gall bladder near its fundus, but it was impossible to detect any calculus. Indeed the question of biliary calculi never suggested itself until combined cholecystography with barium meal examination was instituted, and this was done for the purpose of explaining the cause of the apparent constriction, and with the least expectation of finding a calculus. The striking feature of this case however is the distinct visualization of the calculus with the combined method, and the failure to visualize it with simple cholecystography.^{1,2}

¹ Guisepppe D'A. *Ergebn. d. med. Strahlenforsch.*, 3: 487, 1928.

² Guisepppe D'A. *Fortschr. a. d. geb. d. Roentgenstrahlen*, 34: 705, 1926.



BILIOBRONCHIAL FISTULA

REPORT OF FIRST RECORDED CASE DEMONSTRATED BY LIPIODOL*

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BY definition, a biliobronchial fistula is a communication between the biliary tract and the bronchial tree which permits bile to ascend into the bronchi.

We report herewith what we believe to be the fifty-third recorded case of biliobronchial fistula not caused by echinococcic or amebic infections and the first recorded case where the fistula has been demonstrated by lipiodol injections. Forty-nine of these cases have been summarized by Morton and Phillips,¹ who also report a case of their own. We have found two additional cases recorded since their paper: one by Seelig and Singer,² and one by Meredith.³

REPORT OF CASE

CASE 1. No. 38,423, white, male, forty-two, laborer, was admitted to the Coal Valley Hospital July 19, 1925, complaining of pain in the right upper abdomen. The history was fairly typical of cholelithiasis. The past history was negative except for an uncomplicated attack of typhoid eighteen years before admission, and recurring attacks of subacute polyarthritis, the last attack two years prior to admission.

Examination showed a tall, fleshy man with face flushed; skin dry, rough, and icteroid; and marked jaundice of the conjunctivae. There was definite tenderness over the right upper quadrant of the abdomen with considerable rigidity. There was also moderate hypertension. Examination was otherwise negative except for irrelevant details.

Laboratory examinations provided the following data: The urine was strongly positive for bile, contained a cloud of albumin and an occasional granular cast. The nonprotein and urea nitrogen were very slightly elevated. Blood sugar was normal; gastric analysis negative, hemoclastic crisis test of Widal

slightly positive; urobilin strongly positive; icterus index 33, coagulation and bleeding time normal; and the Wassermann and Meinicke reactions negative.

Roentgenologic examination of the gastrointestinal tract was negative except for an abnormally high position of the duodenum which was interpreted as probably due to adhesions between the duodenum and the gall bladder.

The patient was given a period of preoperative preparation consisting of rest in bed, huge hot wet packs to the liver area, daily hot sitzbaths, and a soft diet, low in fat and protein, high in carbohydrate. Fluids were forced.

Fifteen days after admission he came to operation. The following operative note is copied directly from the patient's record: "Nitrous oxid oxygen plus regional anesthesia. Incision, oblique of Kocher. Stomach normal. The duodenum was normal save for adhesions binding it to the neck of the gall bladder. The liver was considerably enlarged, indurated, edges rounded and boggy, and there was a marked increase in connective tissue trabeculation but no dimpling. The gall bladder was tremendously thickened, filled with calculi, and distended with bile. Fifty cubic centimeters of black, ropy bile were aspirated from the gall bladder; the cystic duct was isolated and a cholecystectomy done. The cystic duct was completely obliterated by scar tissue, therefore, it was impossible to explore the common duct through the cystic duct. The index finger was passed through the foramen of Winslow and the supraduodenal portion of the duct was carefully palpated. No calculi could be felt but the common duct was considerably dilated. The pancreas was enlarged and quite hard. The common duct was incised and thoroughly explored with negative findings. A Horgan tube was placed in the common duct and sutured there. A thickened and adherent appendix was removed; Morrison's pouch was drained, and the abdomen closed in the usual manner."

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The postoperative course was uneventful except that fifteen days after operation the patient accidentally removed the Horgan tube from the common bile duct, following which a small rubber catheter was passed into the drainage tract. Progress continued satisfactorily, and the patient was discharged twenty-seven days after operation, liver function having returned to normal as revealed by a series of functional studies. The jaundice had entirely disappeared. The wound was in satisfactory condition except for a small sinus at the upper angle from which there was a very slight leakage of bile.

The patient was seen again at the end of two months. There had been no jaundice, no clay-colored or tarry stools, or abdominal pain since discharge from the hospital. There had been a moderate amount of flatus but the patient, disregarding dietary instructions, had been eating such foods as fried eggs, fried apples, boiled cabbage, pork, and onions, both raw and cooked, without other discomfort.

Physical examination showed rather marked improvement in the general condition but the small draining sinus at the upper angle of the operative incision was still present. The hypertension had disappeared. Physical findings were otherwise essentially negative.

Laboratory examinations were repeated and the following data obtained: Urinalysis showed a cloud of albumin, pus cells and a few granular casts. Nonprotein and urea nitrogen and blood sugar were within normal limits. Icterus index was 4.8. Urobilin was positive, about two on the basis of four. The hemoclastic crisis test of Widal was negative.

The fact that this patient had so little discomfort following the ingestion of the foods mentioned was regarded as additional evidence that liver function was much improved over its condition at the time of his original admission.

The patient was seen again July 1, 1926, about eleven months following operation. His general condition was satisfactory. There was no flatus, abdominal pain, or food idiosyncrasies but there was some annoying drainage from the sinus at the upper angle of the wound.

At this time the Lahey operation was considered but in view of his generally satisfactory condition and the fact that the discharge was small in amount it was thought best to defer such a procedure until the indication for it became more definite.

The patient did not report to the hospital again until December 31, 1929, three and a half years after the last visit, four years and five months after cholecystectomy. He stated that there had been a continuous discharge from the sinus at the upper angle of his abdominal scar, requiring constant wearing of a thick pad. The discharge was sero-pyoid in character and slightly yellowish in color.

Fourteen days previous to this admission the fistula ceased draining. During the next thirty-six hours a "tingling sensation" gradually developed in the lower right chest, apparently extending upward and centrally from just beneath the incision in the anterior abdominal wall. At the end of this period he began to cough up a sero-pyoid material, greenish-grey in color, at first a small amount, but this gradually increased until the twenty-four hour volume at the time of admission was approximately 500 c.c. Considerable effort was required to raise the sputum, the effort causing intense pain in the lower right chest. The pain disappeared after expectoration of this bile-stained material. Prior to these "fits of coughing" there was usually a sense of suffocation and depression. The frequency of these attacks of coughing was considerably influenced by position, the patient experiencing a choking sensation when lying flat that was usually relieved by coughing up the bile-stained material previously noted. He was unable to lie on the right side because this position caused persistent coughing. The erect and reclining (half-sitting) positions were most comfortable and were accompanied by the least coughing. Stooping did not cause expectoration or precipitate attacks of coughing.

He did not hiccough at any time, a distressing symptom in some of the recorded cases.

It is interesting to note that throughout this long period, during which there was persistent drainage of bile from the fistula, the patient was completely free from jaundice, clay-colored stools, flatus, and unfavorable food reactions in spite of a diet that was far from satisfactory: prima facie evidence that liver function was approximately normal and that an adequate amount of bile was reaching the intestine, notwithstanding the bile loss through the fistula.

Examination at this time showed the skin and mucous membranes normal. The following pertinent positive data were obtained: There

was an area of paravertebral dullness on the right side extending from the level of the spinous process of the ninth thoracic vertebra downward to merge with the liver dullness. About 10 cm. to the right of the eleventh vertebra there was a small area where persistent, fine, bubbling râles were heard. There were no râles elsewhere and the lungs were otherwise negative. The liver dullness extended to the level of the upper margin of the fifth rib at the right midclavicular line. The lower margin of the liver was not palpable. The postoperative scar in the right upper abdomen was firm and satisfactory except that there was a small inverted area near the upper end. Pressure over the scar did not produce pain or cause fluid to escape.

Laboratory examinations provided the following data: Urinalysis showed a cloud of albumin with a few hyaline and granular casts. Icterus index was 6. Nonprotein and urea nitrogen gave high normal values. Wassermann and Meinicke reactions were negative.

Roentgenologic examination of the chest showed the right dome of the diaphragm to be at the upper margin of the fifth rib in the midclavicular line and the upper border of the diaphragm hazy and indistinct.

The following note, five days after admission is taken from the history: "Productive cough continues. The patient is unable to sleep because he is aroused by coughing every thirty to forty-five minutes. Specimens of expectorated material are repeatedly positive for bile. No foreign bodies have been detected in the sputa."

It was believed that elevation of the foot of the bed for a period of one hour three times a day would facilitate drainage and this procedure was attempted but it produced suffocation and had to be discontinued.

An attempt was made to visualize the biliobronchial fistula by injection of iodized oil (through bronchoscope). A series of teleoroentgenograms showed the hazy and irregular right diaphragm already noted. Each of these films showed a definite area of increased density varying from 2 to 3 mms. in width extending from near the hilum into the obliterated right costophrenic angle, the total length of this uninterrupted shadow being 11 cm.

After carefully considering all available clinical and laboratory data it was decided that the high position of the diaphragm on

the right was probably due to a subphrenic abscess and was not entirely dependent upon supradiaphragmatic adhesions.

On January 17, 1930, under local anesthetic, a small incision was made at the upper angle of the old wound. The sinus was located and a probe was passed through it for a distance of about 15 cm., the general direction of the probe being dorsocephalad. Every effort was made to preserve the sinus tract so that it would be in satisfactory condition for performing the Lahey operation if this simpler procedure were unsuccessful. As a result of this probing a thick, creamy, pyoid material exuded. A small catheter was passed into the sinus, and with suction 780 c.c. of this material were removed.

The catheter was left in position to establish free spontaneous drainage and to permit irrigation. Normal saline and Dakin's solution were used for frequent irrigations, the return fluid becoming clear in a few days.

A specimen of pus from the abscess was cultured but no growth was obtained. Stained smears showed a very few staphylococci.

On the day following drainage of the abscess 300 c.c. of a $7\frac{1}{2}$ per cent solution of sodium iodide were injected through the catheter at the upper angle of the wound. Immediately after injection the catheter was removed and a roentgenogram made. This showed a globular mass of increased density about 10 cm. in diameter beneath the right diaphragmatic dome. The upper level of this mass was at the lower level of the fifth rib in the parasternal line. The right costophrenic angle was obliterated.

The iodized oil injections were repeated and a teleoroentgenogram taken. This showed the linear sinus previously noted extending from the right hilum into the obliterated costophrenic angle, merging with the area of increased density referred to in the previous paragraph.

The patient's postoperative course was without event. The cough ceased as soon as the subdiaphragmatic abscess was drained. He was discharged February 1, 1930, cured except for the nephritis which was improved.

A letter from him dated July 29, 1930, stated that his general health is good, that there have been no respiratory infections, and that there has been no coughing of bile-stained material since his discharge. The sinus has completely healed and he has returned to work

CONCLUSIONS

In this case it was not possible to drain the common bile duct via the cystic duct (Lobingier) because it was found, at the time of operation, to be completely obliterated, making it necessary to incise the common duct for the purpose of drainage. The premature (accidental) removal of the Horgan tube probably was contributory to the formation of the chronic sinus. When this closed from lack of adequate pressure the resulting subhepatic accumulation of bile, undoubtedly contaminated because of the prolonged presence of an external fistula, acted as a focus for the formation of the subdiaphragmatic abscess. It seems reasonable to recognize the danger of such a complication from any subhepatic accumulation of bile and in rare cases a biliobronchial fistula may be expected to complicate the picture.

It is also worthy of note that this patient with a prolonged external biliary fistula

was able comfortably to consume a diet that contained fats, onions, and fried foods of all kinds. This fact accords fully with the finding of normal values obtained from liver function studies, it having been demonstrated by Laird, Brugh and Wilkerson⁴ that there is a close parallelism between the values obtained from liver function studies and the clinical condition of the patient with particular reference to his ability to digest fried, fatty, and greasy foods without excessive flatus and those vague digestive disturbances which contribute so much to the discomfort of patients with hepatic dysfunction.

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* Continued from p. 303.

SURGICAL ENDOTHERMY IN SUPRAPUBIC PROSTATECTOMY*

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IN an analysis of a series of 277 suprapubic prostatectomies, 44 performed in one step and 233 in two steps, the

favorable secondary hemorrhage. Despite transurethral irrigation and careful removal of the gauze it has been my experi-

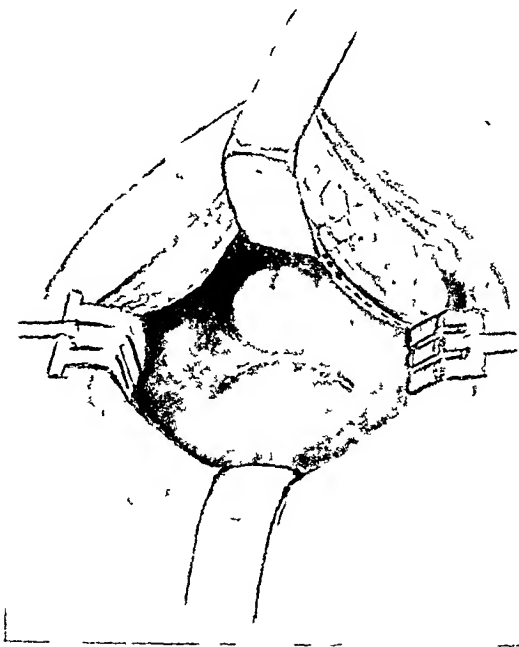


FIG. 1.

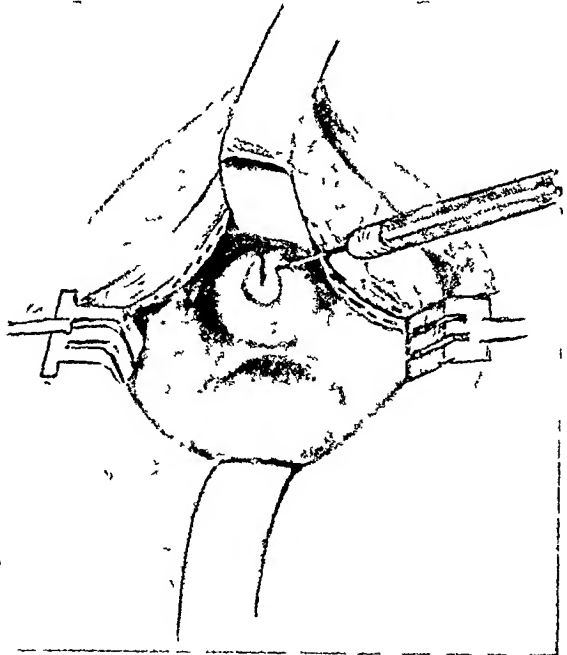


FIG. 2.

most frequent complications entailed by the disease process and the operative procedure for its cure were as follows: renal insufficiency, renal infection, hemorrhage, epididymo-orchitis, vesical infection, delayed healing of the fistula, and secondary stenosis of the vesical neck.¹ To combat renal insufficiency and infection catheter drainage or cystostomy was employed. Catheter drainage carried with it the risk of epididymo-orchitis. Cystostomy necessitated a blind enucleation of the adenomatous mass at a second stage. For the control of bleeding surgical measures were impossible and reliance was placed upon gauze packing of the prostatic bed. While this usually lessened immediate bleeding it

ence that hemorrhage has occurred all too frequently from one to ten days later, requiring repacking of the prostatic bed. Occasionally the removal of the second packing has been followed subsequently by renewed bleeding. It is my firm conviction that the element of infection plays an important rôle in these secondary hemorrhages and that packing introduced into the prostatic bed and bladder is conducive thereto. It is probably a factor in the other phenomena of infection, namely intense cystitis which may be gangrenous or diphtheritic, and virulent ascending infection of the ureters, pelves and renal parenchyma. It may also be responsible for blockage of the ejaculatory ducts and infection of the epididymes. Blind laceration of

¹ Aschner, P. W. *J. Urol.*, 12: 251, 1924.

* Submitted for publication May 8, 1931.

the vesical mucosa, the leaving of loose tabs, the failure to properly reconstruct the vesical neck and the fear of passing instru-

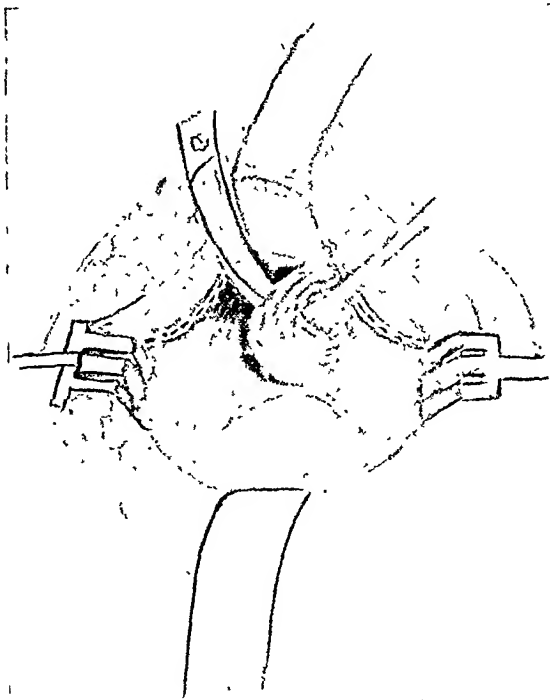


FIG. 3.

ments through the urethra are responsible for the occurrence of late obstructing stenoses, even complete occlusions at the upper end of the prostatic pouch.

To overcome these various complications of the surgery of benign prostatic adenomatous hypertrophy I have gradually developed the following course of procedure. The tentative diagnosis of obstructing hypertrophy having been made by history and physical examination, including the demonstration of residual urine amounting to 120 c.c. or more, the patient is admitted to the hospital. Under local infiltration analgesia, a small incision is made just below either external ring, the spermatic cord delivered, and vas deferens isolated and about half an inch resected between catgut ligatures on both sides. Hemostasis being meticulously assured, the wounds are closed with silk and a small gauze colodion dressing applied. Failure to attend to hemostasis may result in an enormous hematoma of the scrotum.

A soft rubber indwelling catheter is now placed to secure vesical drainage. If there is great retention gradual decompression should be carried out. Bladder irrigation twice daily and changing of the catheter every fourth day after proper urethral irrigation are ordered. There need be no fear of epididymitis, as the vas resection prevents it. The usual functional studies are now made. X-ray examination and cystography are carried out in every case to exclude calculus and diverticulum. The cystogram will also indicate the degree of prostatic encroachment upon the bladder neck. Cystoscopy gives further information as to the prostate and bladder, and the intravenous injection of indigo carmine permits observations upon the renal function and ureteral patency. It is inadvisable to catheterize the ureters unless supravescical calculus is suspected. Intravenous urography (Swick's method) will give much knowledge of the state of the kidneys and ureters.

Vesical drainage having been maintained for seven to ten days and there being no functional or pathological contraindications, the sutures are removed from the inguinal wounds and the prostatectomy is proceeded with. Analgesia is obtained either by combination of sacral nerve block (epidural) and abdominal wall infiltration or by low subdural injection of neocaine, 100 mg., or nupercaine 10 mg. My own preference is for neocaine spinal analgesia as the prolonged action of nupercaine is not necessary here. The indifferent (large) electrode of the endotherm apparatus is placed under the buttocks and sacral region.

A 5 inch median hypogastric incision is made, the linea alba is incised and the peritoneum stripped back from the distended bladder. Guy sutures being passed the water is allowed to empty out through the catheter. The bladder is now opened liberally in the midline of its anterior aspect and its interior inspected. This incision may be made with the scalpel or the endotherm knife. The self-retaining Judd Bal-

four retractor is placed. A broad flexible ribbon retractor over a packing holds the posterior wall taut. A narrow ribbon re-

tractor is placed. A broad flexible ribbon retractor over a packing holds the posterior wall taut. A narrow ribbon re-

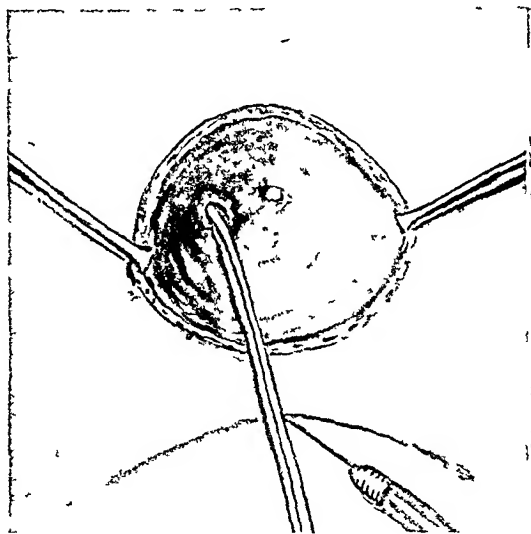


FIG. 4.

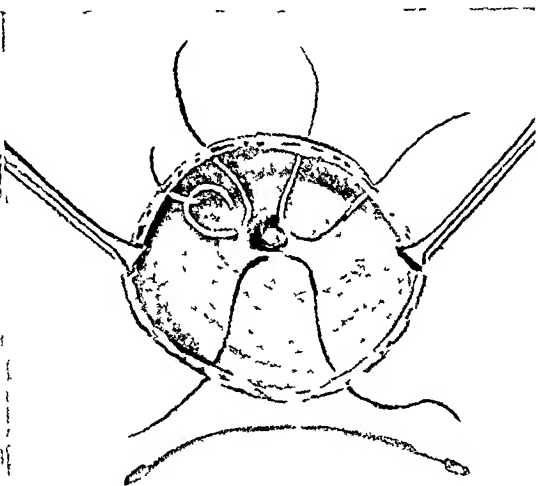


FIG. 5.

tractor exposes the anterior commissure of the internal urethral orifice, and the catheter is now ordered withdrawn (Fig. 1). With the endotherm needle the anterior commissure is divided and an appropriate incision made through the mucosa overlying the projecting prostate and circumcising the urethral orifice. This incision is carried down to the prostatic capsule (Fig. 2). A tenaculum is applied to the prostate and with gentle traction the mass is enucleated under direct vision using a closed blunt curved scissors as a dissector (Fig. 3). As much of the lower part of the posterior urethra is preserved as is possible; it is cut across with the endotherm knife. By the use of Allis forceps to hold open the vesical mucosa rimming the cavity, bleeding vessels are caught with long artery forceps and immediately sealed by touching the forceps with the endotherm needle (Fig. 4). It is not necessary to change the type of current employed. Tabs of tissue are also readily removed with this cutting needle.

Hemostasis being secured in this manner the cut edge of vesical mucosa with its underlying muscularis is sutured down into the prostatic cavity, bringing the mucosa

posterior margin (6 o'clock) using a mattress stitch of zero catgut. One on either



FIG. 6.

side (3 and 9 o'clock) completes the repair converting the prostatic pouch into a funnel wide open above and leading to the

urethral stump (Fig. 5). No bag or packing is used. Hunt, Deaver, Thomson-Walker and Lower use ligatures for bleeding vessels in the prostatic bed, but electrocoagulation is much simpler. Hunt inserts a bag for further hemostasis but I see no necessity for this and it may be harmful. Lower approximates the vesical mucosal rim from side to side leaving just room enough for a urethral catheter, but this, I believe, tends to convert the prostatic cavity and bladder into an hourglass form. It is preferable to convert the prostatic cavity into a funnel, wide open above and tapering down to the urethra (Fig. 6.) as is done by Hunt, Deaver and Thomson-Walker.

The bladder is now closed with interrupted plain catgut sutures around a tube 1.5 cm. in diameter led out from the vertex of the bladder. Reinforcing sutures of chromic catgut are then placed approximating the outer layers of the bladder wall. A packing to the space of Retzius, and another to the peritoneal reflection are inserted and the abdominal wall closed about the drains. A week later the tube

and packings are removed and a urethral catheter may be inserted as before operation. Irrigation is then used only to maintain free drainage. The wound is found to close completely in from fourteen to twenty-one days. There has been no more bleeding than is frequently seen after simple cystostomy. In one of the earlier cases, not having complete confidence in the procedure as a preventive of bleeding, I placed a packing in the funnel area. This patient was slow in healing and later developed some stenosis. The worst risk was a man of seventy-one with blood urea of 90 mg. and blood sugar of 500 mg. on admission with complete retention.

The procedure is not applicable to those patients in whom indwelling catheter drainage cannot be employed and in whom cystostomy must be resorted to for adequate preparation. The presence of vesical calculi also necessitates the two-stage procedure. In the event that a two-step prostatectomy is necessary packing of the prostatic bed may be frequently dispensed with, and should be avoided whenever possible.



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* Continued from p. 335.

FRACTURES OF THE SPINE*

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FRACTURES of the spine at best present a difficult problem, if one is to return the patient to full function at his former occupation. Until quite lately, the profession generally seemed to be content with fixation, in spite of deformity. Considerable skepticism existed as to the ability of the vertebral centrum to repair its fractures, with the result that a great many patients having simple uncomplicated crush fractures never returned to their former occupations. The majority of them came into the hands of the extremity surgeon so long after the initial fracture, that spinal fusions were frequently necessary. Results from methods which attained only partial correction, left much to be desired from the standpoint of function. The patient with a fractured spine was indeed to be pitied, because he usually endured a fixed position prohibiting adequate nursing care. This position had to be retained for months, and in the end, the x-ray showed varying degrees of deformity. The occasional case that was symptom-free and fully functioning, was either the fused case or the one in which nature had fused the immediate region of the crush, presumably for the usual reason that nature fuses joints elsewhere.

What then may be considered the ideal of treatment and care? First, as nearly perfect anatomical repositioning of fragments and restoration of alinement as obtains in fractures elsewhere in the body. Second, a detailed plan which anticipates from the beginning, all the steps necessary to return the patient to his former occupation. Third, a simplification of method which takes into account the comfort of the patient and permits ready access to all parts of the anatomy for the treatment

of associated fractures, pneumonia, and the various complications ordinarily encountered in the treatment of severe fractures. Frequent change of position requires a special splinting apparatus. From the point of view of the best care of an individual fractured spine, treatment should be taken to the place where the man is injured, because of the damage which may occur as a result of transportation for long distances. The method therefore should utilize materials universally available.

MECHANICS OF PRODUCTION OF CRUSH FRACTURES

The anatomical peculiarities of various sections of the spine have a distinct bearing on the nature of the fracture. The cervical vertebrae are broad, shallow, with thick intervertebral discs and large range of motion. The typical fracture in this region is the dislocation with perpendicular fracture through the thickness of the centrum. The thoracic vertebrae are taller, smaller in circumference and their posterior arches overlap each other in shingle-like fashion. In this region the incidence of crush fracture increases. In the lumbar region the main peculiarity is the high anterior vertical diameter and great mobility.

Various authors have shown the great preponderance of crush fractures at the dorsolumbar junction. The incidence in this region is as great as 70 to 80 per cent, (see Fig. 1) so that if one were to elect for treatment, the region of the spine most affected by fracture, it would appear worth while to focus attention upon this region, realizing however, *that no one method can be used for all spinal fractures.* The detailed nature of the fracture depends upon the varying anatomical structure of

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the section of spine involved, so with this point in view, it follows that each case demands individual interpretation of

125 Bodies Involved in 82 Cases.

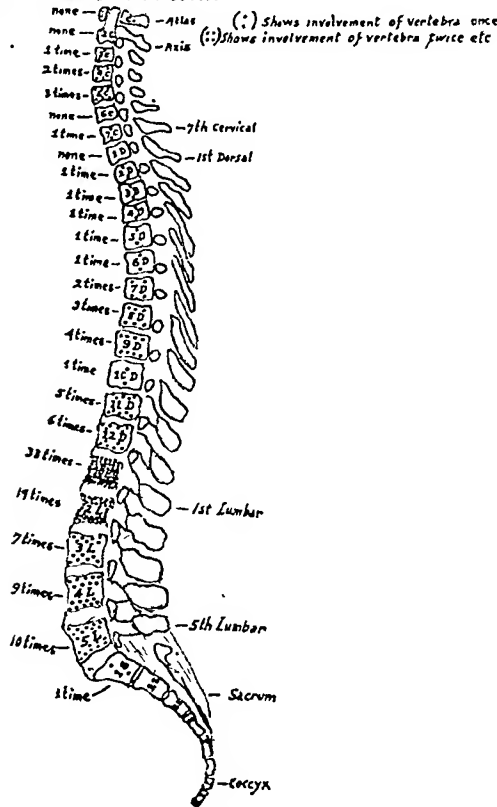


FIG. 1. Relative frequency of fracture involving various individual vertebrae. (Courtesy of Dr. J. O. Wallace, Pittsburgh.)

method. The fact that crush fractures involve principally the dorsolumbar spine and are most frequent in the first lumbar vertebra, points to peculiar structural vulnerability in this region. The chief reasons for this vulnerability may be summed up as follows:

1. The rather common observation that vertical stresses if not dissipated by the resiliency of the well defined thoracic and lumbar curves meet at the junction of these curves which is the region of the tenth dorsal to the second lumbar.

2. The fact that in normal flexion the lumbar spine never moves further than to eliminate its forward convexity to the point of becoming straight or nearly so.

3. The increased anterior vertical thickness of the lumbar vertebrae renders the anterior half of the centra especially vulnerable to vertical force or stresses in flexion.

4. Purely vertical stresses are deflected forward from the dense, highly resistant, lateral masses and posterior arch on to the less resistant spongiosa of the centra. An analysis of the relative cortical bone density demonstrates that the pedicles, articular processes, and posterior aspects of the vertebrae to be much stronger than the cortex of the body. The cortex is thinnest at the midmost portion of the body.

5. Of a more speculative nature but none the less real as affecting the mechanics involved, the following general observations are worth considering:

- (a) Most attitudes during work or rest are with the spine flexed in varying degree.

- (b) According to the usual history the injuring force is extremely sudden and therefore allows no time for escape.

- (c) Danger from in front usually allows sufficient respite to permit escape due to visual warning. Thus with the exception of falls from a height the injuring force usually approaches from above or behind explaining another factor productive of flexion at the moment of impact.

For the problem at hand the torso may be considered as composed of two main levers. An upper, longer, relatively fixed one composed of the dorsal spine and thoracic cage; and a lower, shorter, flexible one, composed of the 5 lumbar vertebrae, loins, and abdomen. The imposed gravital stress of body weight and accidental force, all tend to move this relatively fixed dorsal region as a mass forward and downward upon the stronger, more mobile, lumbar spine, which after eliminating its forward curve, "fetches up," resisting further flexion. The forward moving thoracic mass as the upper lever, combined with the extending lumbar spine, places the fulcrum at, roughly,

the first lumbar. The hinge of action of the levers is therefore in the immediate location of the first lumbar. A complete dislocation forward is prevented by the overlapping of the articular processes; nevertheless, a sufficient degree of flexion of these joints occurs to permit a *varying degree* of dislocation forward. Coal mine cave-ins are frequent causes of crush fractures. Two elements usually obtain in the force applied, that is, a vertical and horizontal stress in the shoulder region. The vertical element produces the fracture which, if not a completely impacted crush, breaks off the anterior lip of the centrum, chancing at the moment to be located at the summit of the suddenly produced flex. The junction of the dorsal and lumbar segments combined with the elimination of the lumbar forward curve, then forms at once the summit of the flex and the hinge of the movement.

Wilson,¹ Cotton,² Abbott,³ Wallace,⁴ Magnuson,⁵ Kirchner,⁶ Osgood,⁷ and various foreign clinics, have pointed to the desirability of hyperextension in the treatment of crush fractures of spine, and various methods were in use, none of which however, aimed at complete reduction of the anterior vertical diameter. In foreign clinics a form of head suspension with the head of the bed elevated and a pillow under the point of fracture, seems quite universal. Bradford frames and plaster shells with felt padding were most commonly used in this country. It would appear that the reason adequate hyperextension has not been done regularly heretofore, was because of fear of consequences. A particular case (Fig. 3) with peculiar distribution of paralysis and great distortion of alinement (jack-knifing) prompted me to hyperextend far beyond what accustomed practice dictated. The fact that this particular patient was not damaged by hyperextension, but, on the contrary, returned to normal in a shorter time than usual, with a complete disappearance of the paralysis and unusual restoration of alinement and vertical height

suggested that the same method be used regularly and also prompted on investigation to show reasons why a calamity

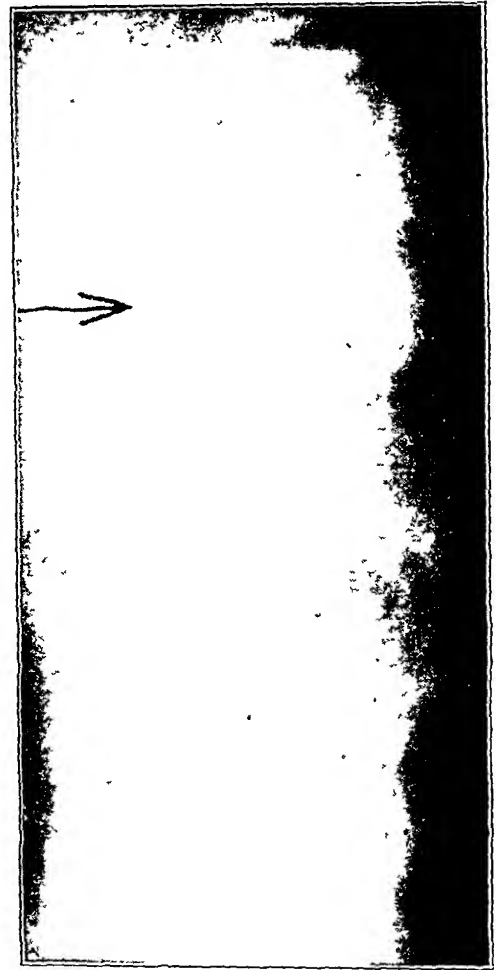


FIG. 2. C. V. B. No. 31828, showing 50 per cent loss of A. V. D.*

did not follow this apparently radical procedure. A detailed study of the lumbar spine and the various structures serving to unite vertebrae, together with the detailed nature of the usual crush, brought out various reasons why adequate hyperextension to the point of actual reduction, can be safely executed.

A prior paper⁸ setting forth a method and anatomical interpretations appeared in the *Journal of Bone and Joint Surgery*. Thirty-four cases of fractured spines including 13 crush fracture reductions, were cited in detail. From a reading of this

* A. V. D., abbreviation for anterior vertical diameter.

paper it will be seen that the principles involved in the *reduction* of crush fractures are none other than the general principles

of shell treatment, followed by an average of six or seven weeks of convalescent, ambulatory treatment with hyperextended

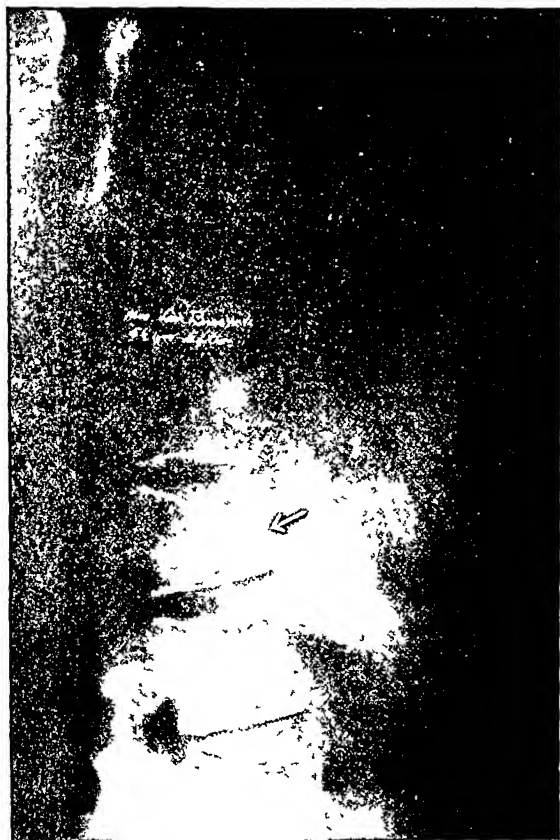


FIG. 2A. Same as Fig. 2. Five and one-half years after, showing restoration of A. V. D. Spine is symptomless, and fully functioning for past five years.

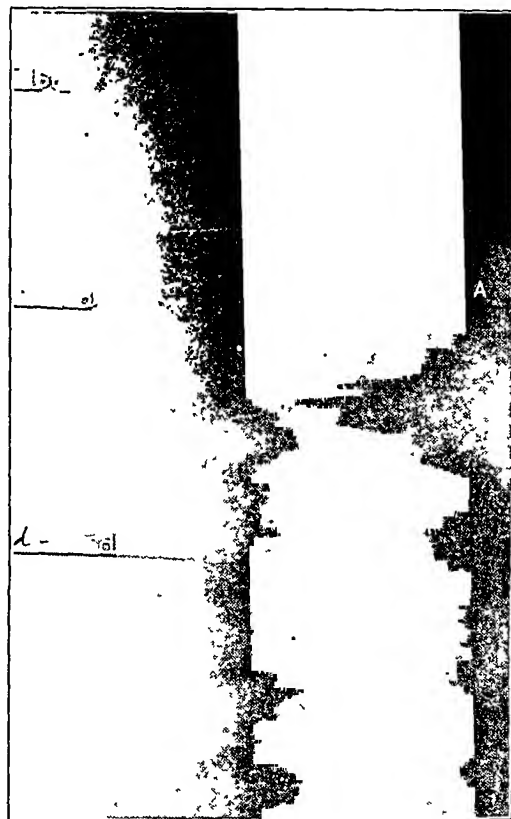


FIG. 3. D. C. No. 35905. First case of manipulative hyperextension. Complete motor, partial sensory paralysis from groins to toes. Complete reduction not attempted. Note projection of posterior superior angle of centrum into canal.

governing the reduction of fractures elsewhere in the anatomy. The method does not depart from the general rule but rather it realizes more fully the application of the general rule to the particular part involved and takes cognizance of the fact that spinal anatomy and physiology require a different method of application of general principles than do the long bones. The fact also that reduction in a crush fracture involves disimpaction calls forth a modification of approach. The paper showed that crushed vertebrae could be completely reduced regularly with complete or almost complete restoration of anterior vertical height. The procedure of reduction and making of shells requires an hour and a half. There was then an average period of seven weeks

Taylor brace or jacket. Since then the number of crush fractures in my own hands, and in the hands of others, in which this manipulative reduction method was used, has been materially increased. Somewhere between 75 and 100 cases to my knowledge, have been treated by this method, and while there has been no searching analysis made of this group, if one can judge from the reports, complete reductions have been the rule. Return to former occupations has averaged three or four months from the date of accident, materially reducing the convalescence. Only one unhappy result has so far been reported. This is a case of Dr. Clay Murray of New York City, who states

that his patient died within two days after reduction, but according to Dr. Murray's searching analysis and autopsy there was

several transfers usually necessary, by having the stretcher taken directly to the x-ray table. *Before moving, a draw sheet is*

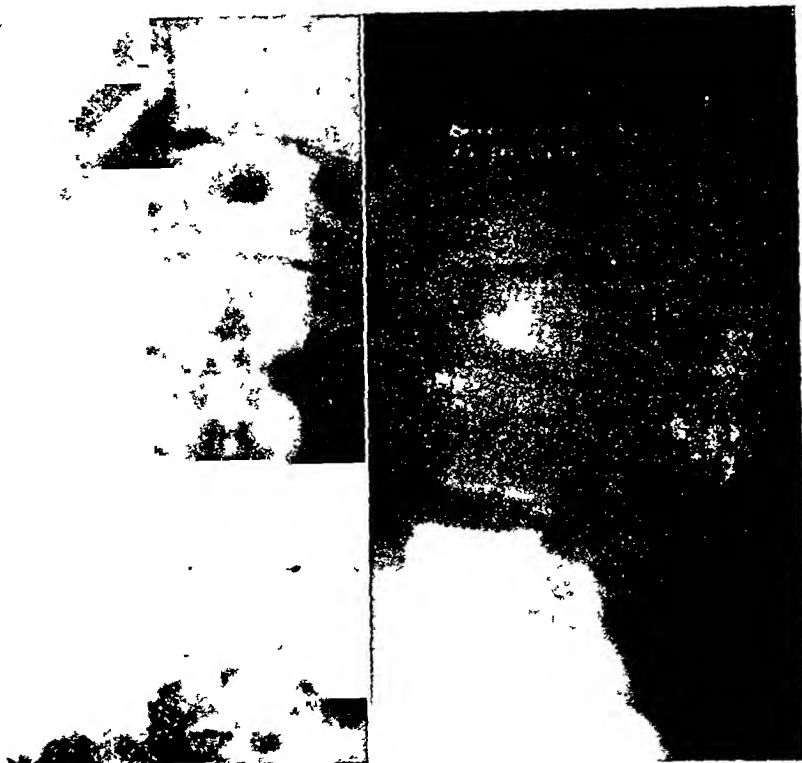


FIG. 3A. Partial restoration of A. V. D. Fair correction of alinement. Spine has been without symptoms and fully functioning for past four years. Note lateral spur.

no evidence that the method of reduction was responsible. The final diagnosis was hematomyelia.

It seems advisable that where spinal fracture is suspected it is important not to make a general examination that disturbs the position of the patient. After a narcotic the first responsibility is the immediate thorough-going x-ray. Very often the first film is not sufficiently detailed and of course it is absolutely necessary to obtain antero-posterior and lateral views. McCutcheon⁹ describes an adequate technique. The difference in permeability between the supradiaphragmatic and infradiaphragmatic region must also be allowed for. It may often be necessary to take several lateral views of the dorsolumbar junction to show the necessary detail. I personally supervise the handling of the case at the time of x-ray whenever possible in order to minimize the trauma incident to the

placed around the patient and the patient is rolled rather than lifted or shifted for the necessary position. It seems quite possible that an unparalyzed case may easily become paralyzed through unintelligent handling.

Since the method appeared, there have been a number of questions asking for more details concerning the type of manipulation and whether or not an anesthetic is necessary. The great majority of cases are reduced with anesthetic and without manual manipulation at the point of fracture. Avertin seems the preferable anesthetic, but many cases require no anesthetic. The manual manipulation is reserved for those cases in which the ordinary suspension does not result in complete disappearance of the kyphos. In such cases, several quick but measured downward thrusts are made with thumbs on either side of the spinous process of the

involved vertebra. It is thought that the impaction in this latter type of case is considerably greater than usual and of

ing difference between a crush fracture treated, from the first, by recumbency and an untreated, overlooked fracture. In the



FIG. 4. C. E. No. 41367 Considerable collapse and angulation, coincident chronic arthritis.



FIG. 4A. Fair reduction of A. v. D. Correction of alignment. Fully functioning symptomless spine. Returned to former occupation as carpenter four months following injury.

sufficient strength to render disimpaction impossible by passive hyperextension.

LATE RESULTS

Grave doubts may be entertained regarding the ability of the collapsed spongiosa to fill in the defect after restoration of contour. Besides, the possibility of a sequel such as Kümmel's disease might well be entertained. The answer to these two questions is that a close followup has been possible in the cases cited and that there has been no experience of this kind to date. All of the patients having crush fractures have returned to their various occupations except one, and here the outcome was befogged by circumstances beyond ordinary control. Moreover, if my impression is correct there is an outstand-

latter case the constant movement of fragments incident to superimposed weight and motion must of necessity compress the body and make for non-union. Six cases are shown herewith (Figs. 2-2A, 3-3A, 4-4A, 5-5A, 6, 7) from one and one-half to six years following crush fracture. With the exception of one arthritic and another in which only partial reduction was obtained, these show no ankylosis, no narrowing of the vertebral substance, and all have fully functioning, symptomless spines. This evidence tends to show that the centrum of a vertebra is surely as capable of forming adequate weight-bearing callus as are other bones. No doubt many normal functional recoveries have occurred with the use of jackets, pure head

and foot traction, the Glisson sling, Bradford frames, waterbeds, plaster shells, ordinary recumbency, etc.; but that this

operative and the manipulative reduction method, it seems there is little or no evidence in favor of the former and every-

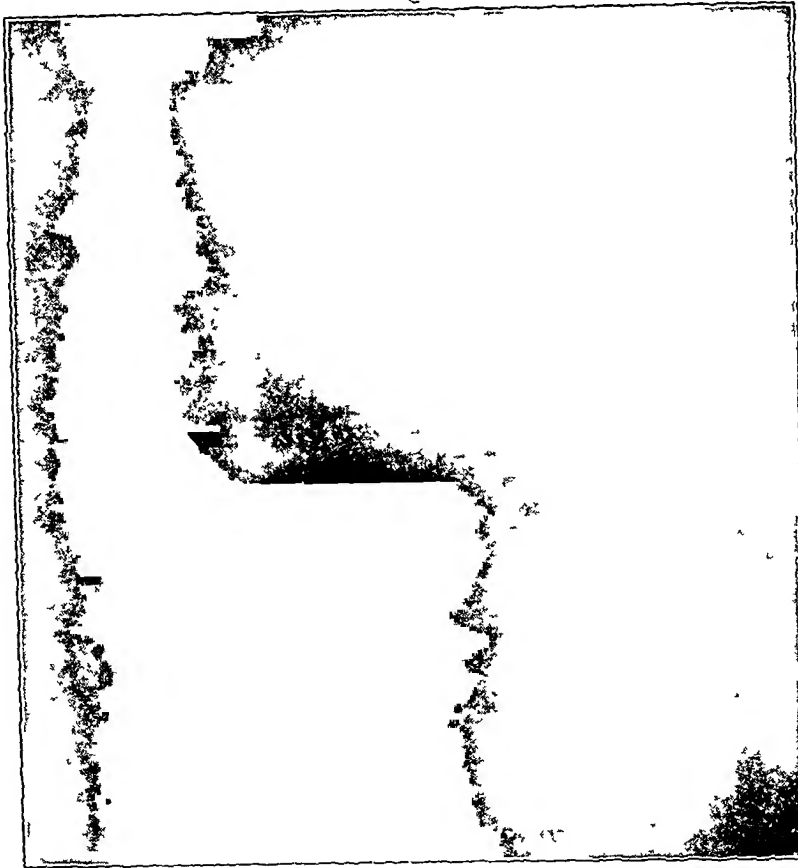


FIG 5. G. G. No. 33527. Loss of one-half the A. V. D. with displacement of anterior upper fragment forward and downward.

sort of quasi-treatment is adequate for the average case is at least very questionable. The average case, given this paucity of treatment, yields too large a percentage of sequelae. The aftermath of root symptoms, "lame backs," and progressive bone deformities is largely if not completely preventable. It is this type of result that requires the internal fixation of a segment of spine to effect a symptomless back.

In reference to the routine or frequent use of fusion operations in fresh crush fractures, it may be worth while to comment. Osgood⁷ is frankly against operative interference in fresh crush fractures. Cleary¹⁰ on the other hand is convinced of the value of a fusion operation as a routine, and is commended by several for his attitude. As to the relative merits of the

thing to recommend the latter. Since recovery of a fracture depends primarily upon callus formation, there can be no gain in time as a result of operative interference. It seems only logical that bone formation proceeds with the same speed in the case of the fractured centrum as it does in the artificially fractured spinous processes and laminae. While operation accomplishes adequate splintage only after solid fusion takes place, it also confirms the deformity, so that whatever narrowing of vertical thickness, or disalignment exists, is permanently fixed. On the other hand manipulative reduction corrects deformity and disalignment, besides restoring vertical thickness. The shells provide adequate splintage from the beginning. The operative fixation of 5 vertebrae into a solid

piece means a permanent decrease to some extent at least in range of motion of the spine as a whole. The conservative

authors including Elsberg's¹¹ data on 872 cases of various authors are disheartening. The observations of Sharpe,^{12,13}

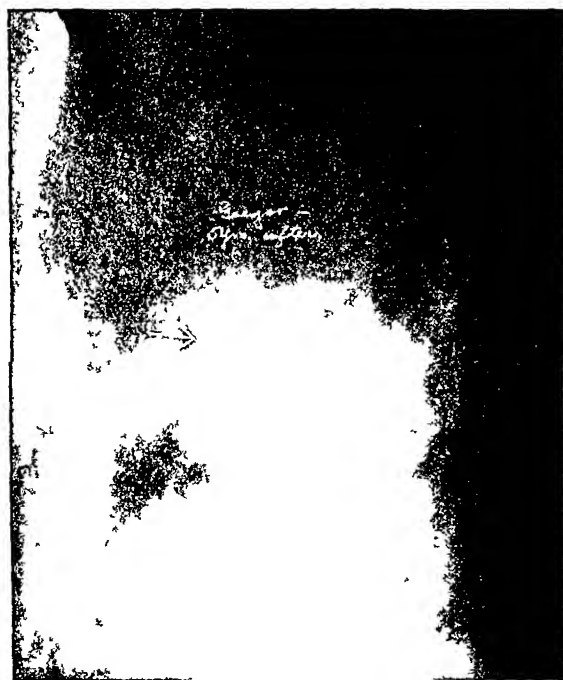


FIG. 5A. Complete restoration of A. v. D. Anterior upper fragment fairly well restored. This patient returned to construction work four months after accident and has had a fully functioning symptomless spine since then.



FIG. 6. C. C. No. 72944. Original films not sufficiently clear to show collapse. Case is one of a fireman who returned to work five months after fracture. Figure shows restoration of A. v. D. and of anterior upper corner of centrum. Symptomless, fully functioning spine for past two years.

method does not compromise spinal motion. It therefore seems that operative fixation is not only unnecessary but also questionable treatment in the great majority of *fresh* crush fractures. Spinal fusion however will probably continue to be necessary in the occasional neglected or inadequately treated case.

FRACTURE DISLOCATIONS WITH PARTIAL OR COMPLETE CORD INVOLVEMENT

No exact line of demarcation can be drawn between the simple crush of a centrum without cord involvement and the other extreme of complete shearing of spine and cord, for which nothing can be done. No rule can be made to differentiate with certainty the case that requires a laminectomy from the one that requires hyperextension only, and the one that requires both. The statistics of many

Taylor,¹⁴ Hartwell,¹⁵ Plaggemeyer,¹⁶ Speed,¹⁷ Mixer,¹⁸ Burrell and Crandon,¹⁹ Hoy,²⁰ and others offer a wide divergence of views and prescribed treatment.

A preponderance of evidence can usually be adduced for conservative or radical procedure. On the other hand arriving at the proper conclusion for the individual case at hand depends more upon a careful evaluation of the many factors involved. The factors usually the most prominent in determining the method may be classified as follows:

1. The detailed x-ray picture.
2. The extent of paralysis, partial, complete, or peculiar, in distribution.
3. The detailed anatomy of the particular section of spine and cord involved.
4. The amount and nature of x-ray deformity in relation to the spinal canal and its reducibility or irreducibility by manipulation or laminectomy or both.

5. The probability of transitory edema, contusion, compression, or hopeless transection concerning which conclusions are frequently impossible or at least extremely difficult to arrive at.

6. The time element, urgent in relation to progressive paralysis, hematomyelia, compression, or laceration; equally important as regards postponement of operative means where shock or other formidable complications prohibit.

The impression one gathers from the literature is that laminectomies are frequently done with little thought devoted to reduction of dislocation or deformity, or to adequate splintage afterward: pinning faith upon operation only, while the non-operative measures frequently seem the paramount consideration. The status of the cord being the all important question, is it not as necessary to restore the spinal canal to its maximum diameter and normal contour as it is to decompress by laminectomy? Given an immediately successful result with laminectomy what will the final outcome be if spinal deformity is not corrected? Bony compression of the cord is most frequently due to impingement of the sharp posterior superior angle of the centrum. The exact differentiation between edema, contusion, hemorrhage and compression is usually difficult during the first few hours when incision of the posterior commissure is of greatest value. The results of laminectomy *per se* are universally discouraging. The intensity of the trauma required to produce a fracture dislocation is usually sufficient to produce grave shock and a bad operative risk. Therefore, since these factors frequently obtain, the certainty of manipulative reduction with its accompaniment of restored caliber seems to outweigh or at least should precede operative interference.

On the other hand, the ultra-conservative attitude is equally untenable in view of the experimental work of Allen,²¹ who points to the necessity of laminectomy and incision of the commissure within the first five hours, if cord degeneration is

to be forestalled. Cases of depressed posterior arch with fracture of laminae and paralysis are certainly an indication



FIG. 7. Another case showing typical restoration of A. V. D. and anterior upper corner fragment. Also symptomless and fully functioning for past one and one-half years.

for operative removal of the compressing fragments. Cases showing definite signs of increasing paralysis along with definite evidence of continuity, would appear to indicate a combination of laminectomy with manipulative reduction, the latter usually preceding the former. So it seems that every paralyzed case should be approached with an open mind as to the necessity of either *operative or manipulative method or both*.

Approaching the problem from another angle, viz., in regard to the reaction of non-medullated cord tissue and grey matter to trauma, Elsberg,^{22,23} Allen,²⁴ Frazier,²⁵ Wilson,²⁶ Farquhar Buzzard and Percy Sargent,²⁷ and Kocher,²⁸ all point to the relative futility of spinal cord incision and to the absence of nerve regeneration except in the cauda equina.

A number of partially paralyzed cases in my own hands and others, appear to demonstrate that manipulation into hyperextension is an eligible consideration in selected cases of fracture dislocations with

cord involvement. *The most frequent bony pressure is exerted by the posterior superior angle of the centrum.* This type of compres-

in an emergency, a sufficient number of pillows or other materials to obtain and maintain hyperextension, all seem eligible.

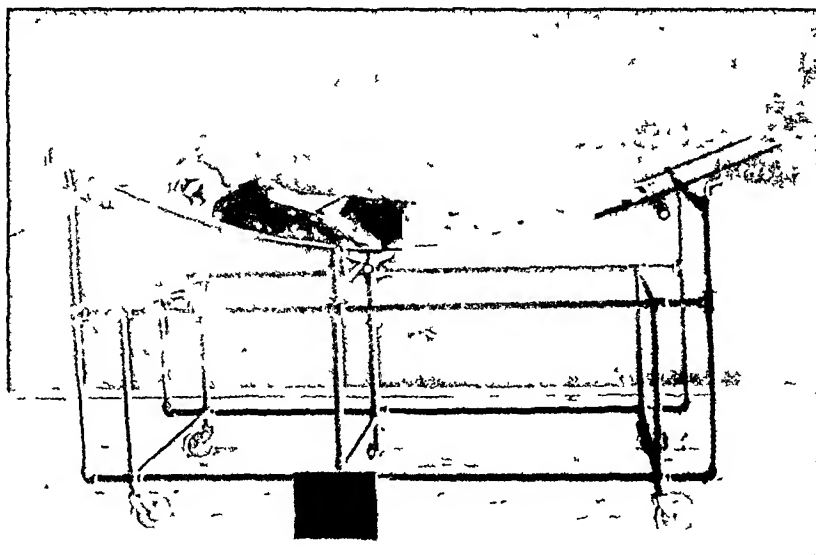


FIG. 8. Modification of Rogers frame. Raised and lowered by gears to permit prone or supine hyperextension.

sion of cord is similar to that of tuberculous impingement or in other words, directly due to jack-knifing. It would be physically impossible to remove such pressure by laminectomy but on the other hand it is rather simple to remove such pressure by hyperextension. The decompressing factor resulting from hyperextension is due to the fact that the spinal canal is restored to its greatest diameter. in any event, with a severe fracture dislocation accompanied by complete or nearly complete paralysis, it appears that hyperextension and adequate splinting should precede laminectomy, because without reduction of deformity, the future function of the patient will be indeed questionable.

CHOICE OF METHOD

It matters little what method is used so long as complete hyperextension with reduction, as measured by the anterior vertical diameter, is gained. The ingenious method of William Rogers²⁹ uses a frame to gain immediate or gradual reduction. The method of Dunlop,³⁰ the method of Wallace,⁴ or the simple method of using,

In the average case of crush fracture, especially the ones with partial paralysis, it would appear to be an advantage to obtain the reduction immediately, thereby converting prolonged bony pressure on the cord to a more transitory contusion from which the cord may recover. In industrial areas, where very severe multiple fractures are common, and internal organ complications are frequent, immediate reduction and splinting in double shells is imperative.

The only serious objection to hyperextension in dorsal decubitus, is in the case of fractured laminae. The gibbus, the apex of which is represented by the tip of the spinous process, must not be made to impinge against a rigid object during reduction. Pressure upon the apex of the gibbus may very easily project a fragment of bone into the spinal canal. Also the fact that fractures of the laminae are difficult of x-ray exposition, adds another factor of uncertainty. Such a calamity may be avoided by hyperextension in the prone position, either by the manipulative hyperextension method or with a Rogers frame so constructed

as to produce the necessary degree of hyperextension in the prone position (Fig. 8).

An advantage possessed by manipulative hyperextension is that in the common crush fracture at the dorsolumbar junction, the hyperextension is being practically limited to the lumbar spine. The arc of extension is actually obtained at this point, while in the case of a hyperextensible frame in dorsal decubitus, the pressure of hyperextension is exerted practically as much on the dorsal inflexible spine as it is on the lumbar spine; thus the hockey stick curve described by Lovett as typifying hyperextension, is not as easily produced by a symmetrical arc, as in the case of an arc the lumbar limb of which describes a much sharper curve than the dorsal limb.

SUMMARY

1. Complete reduction of fresh crush fractures is possible when adequate hyperextension and fixation are accomplished early.

2. Several adequate methods of hyperextension are now available, the particular method depending upon the apparatus immediately available, and the special features of the case at hand.

3. Restoration of vertebral contours and spinal alinement are essential to complete restoration of function.

4. The vertebral centrum is capable of forming adequate weight-bearing callus.

5. The double shell and rolling method reduces the labor and increases the safety and comfort of the patient considerably.

6. Convalescence from crush fractures has been materially shortened.

7. Hyperextension and shells are not only applicable but highly desirable in

many cases of *fracture dislocation* of the spine with paralysis.

DISCUSSION

Dr. Swift's description of the fractures of laminae and pedicles is extremely interesting. It is not surprising that with the advantage of actually seeing through an incision that these fissure fractures occur. Obviously with the overlapping, intricate, structure of vertebrae, the x-ray would not be expected to show such fissures. On the other hand, any considerable displacement of such fractures would be more likely to show, and one wonders whether fissure fractures without displacement need seriously concern us. I want to ask Dr. Swift if he has seen appreciable displacement in these fractures of laminae and pedicles.

It is significant that both Dr. Rogers and myself depend upon the posterior arch to bear the weight during convalescence. Dr. Rogers has gone further in allowing the patients to be ambulatory in extreme hyperextension, at a very early date, in a well-fitting jacket. Perhaps Dr. Rogers' method of early weight bearing is the better, but personally I always had in mind the possibility of the hidden fractures of the posterior arch, mentioned by Dr. Swift. In my own cases, we fit a well hyperextended Taylor brace after about six to seven weeks of shells. The patient is taught how to use it. The brace is applied with the patient prone and the brace altered until adequate hyperextension is obtained. The patient then possesses the advantage of being up and active in about six weeks, and in this way hardens his callus, preventing later collapse.

If it can be demonstrated in a particular case that the laminae are fractured on both sides, such cases would appear to contraindicate any method which exerts pressure against the spinous process. The fact that the laminae are fractured means an unusual traumatizing force, tending to produce hyperextension and not usually associated with crush of the centrum. The removal of such posterior arch may be imperative.

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[For Remainder of References see p. 324]

OSTEOGENESIS IMPERFECTA*

REPORT OF NINE CASES

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NINE cases of osteogenesis imperfecta, sometimes called fragilitas ossium, are here reported, eight of which are



FIG. 1. Osteogenesis imperfecta congenita, Case v. Multiple fractures of long bones in a child three days old.

of patients at the Hospital for Ruptured and Crippled, the ninth being a patient who was admitted to the Orthopedic Service at Bellevue Hospital, and operated upon about one year ago for correction of the marked anterior bowing of the tibiae. This last case is of particular interest and is reported in some detail. All these cases were characterized by an imperfect development of the bones, and the presence of blue sclera.

Osteogenesis imperfecta is a systemic condition of unknown origin, two types of which have been reported. Loebstein

described the condition in 1835, pointing out that fractures are often noticed early in infancy or in the first few years of life. In 1849 Vrolik described the type developing in fetal life, these cases frequently being still births or dying shortly after birth. This has been given the name of osteogenesis imperfecta congenita, and is illustrated by Cases v and vi. The bone fragility may persist throughout life, although usually, if these patients live to adult life, the tendency of the bones to fracture decreases as seen in Cases viii and ix.

In the last case presented, no fractures had occurred for ten years, but the marked residual bowing of the long bones, particularly of the tibiae, was striking.

The etiology of osteogenesis imperfecta is unknown. In some of the cases reported there is a familial tendency and Constans reports two cases illustrating this. In one of his cases the mother had blue sclera, deafness, and frequent fractures, while her brother had blue sclera but no history of fractures. In the other case the father and brother had blue sclera and a history of frequent fractures, and the three children of the patient's brother had blue sclera and a history of frequent fractures. In the cases I have seen there has been a rather striking absence of familial or hereditary tendency. Endocrine disturbances have been thought to be a cause but no definite data can be advanced to substantiate this, although several writers are impressed with the possible rôle of the parathyroid as a causative factor. Severe trauma occurring late in pregnancy, amniotic bands and intrauterine adhesions have all been mentioned by various writers as predisposing factors, but as yet definite

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proof is lacking. Syphilis definitely does not seem to be a factor.

While opinions differ as to the method of

long bones involved in weight-bearing. The vertebrae as well become deformed so that the patients are usually of short



FIG. 2. Osteogenesis imperfecta congenita, Case vi. Malunion of long bones following fractures in a child six months of age.

abnormal formation, bone fragility is the outstanding feature of the condition. Sigowa states that the pathological process consists in a disproportion of the building-up and the breaking-down activity leading to osteoporosis. Axhausen believes that there is a mal-deficiency of periosteal bone formation on account of the lowered function of the osteoblasts. Whatever the reason, it is obvious that during the active period the bones are delicate in structure and fractures may occur by the patient merely turning over in bed. One parent in this series stated that her child's bones were "like glass."

The roentgenographic appearance is characterized chiefly by a decrease in the lime salts. The bones become soft, and in part cartilagenous, giving rise easily to multiple fractures or bowing of the



FIG. 3. Marked callus production during healing stage. This is in marked contrast to those cases in which the process is arrested. See figures 5 and 7.

stature. In the acute stage a roentgenographic examination may disclose multiple fractures which have united with marked callus formation, in spite of the decrease in the calcium salts of the bones. In the cases in which the bone fragility has been arrested, it has been frequently noticed that deafness is a common complication, the explanation being that it is due to an abnormal deposit of calcium salts in the small bones of the ear.

In these older cases the fractures heal slowly with an absence of any marked callus formation, as shown in the case of this series in which an open operation was performed. In these older cases the cortex of the bone is thickened and very hard and the contour of the bone is remarkably altered.

The blue sclera are an essential part in this syndrome. It has been said that not all patients who have blue sclera possess bone



FIG. 4. Marked anterior bowing of right leg in Case ix. Note thickened cortex indicative of process of bone fragility being inactive.

fragility, but that all cases presenting fragility of the bones have blue sclera. This color is thought to be due to a decrease or absence of the quantity or quality of the fibrous tissue, allowing the choroid to show through the thin sclera. In the cases reviewed it was noticed that during early life the sclera were of a characteristic pale china blue, while in the older cases the color was of a distinctly darker blue.

The blood chemistry in these cases has often been studied, and in most of the cases has been found perfectly normal. In only one patient of this series was the blood chemistry carefully studied, and nothing abnormal was noted.

The treatment of osteogenesis imperfecta is naturally one of protection, as no medicine is of any specific value. These patients usually find it necessary to lead very guarded lives and many of them

become bedridden and need institutional care. Fortunately with these early cases the fractures heal readily and reduction is usually simple. In the older cases in which the process appears to be arrested attention can be directed to correcting the residual deformities by osteotomy. Healing is usually much delayed in these older cases so that a long period of immobilization is necessary and often braces may be required to protect against subsequent injury.

CASE REPORTS

CASE I. F. B., a female child, came to the clinic at the Hospital for Ruptured and Crippled on September 5, 1928, walking with great difficulty. The child was ten years of age, 50" high, markedly overweight, with the characteristic blue sclera, complaining of pain in the hips on walking. The mother stated that the child had had her first fracture of the thigh when four days old, but that the family history was negative for any similar condition. She gave a history of having had sixteen fractures in the lower extremities, and x-rays of the long bones of the lower extremities revealed slender deformed shafts, with marked decalcification, with evidence of a number of previous fractures. She came to the clinic on account of a subtrochanteric fracture of several months' duration which appeared to be healing well but with a marked degree of coxa vara. When last heard from the patient was bedridden, receiving institutional care.

CASE II. D. G., a male child sixteen months of age, was brought to the clinic at the Hospital for Ruptured and Crippled February 18, 1929 with a history of having had numerous fractures of the long bones. He was brought to the hospital because the left femur had been fractured twenty-four hours previously, the mother stating that the bones fractured frequently when the baby was being cared for. The child and mother presented blue sclera, but no history of a similar bone fragility could be obtained from any member of the family. Patient was sent to an institution for care and observation.

CASE III. A. S., a female child eight years of age, was brought to the clinic at the Hospital for Ruptured and Crippled on August 26, 1929.

The mother stated that twenty-four hours previously the child had slipped from a chair, fracturing the left thigh. The patient presented

tibiae, and a roentgenogram of the entire body showed multiple fractures with striking secondary deformities due to the softening

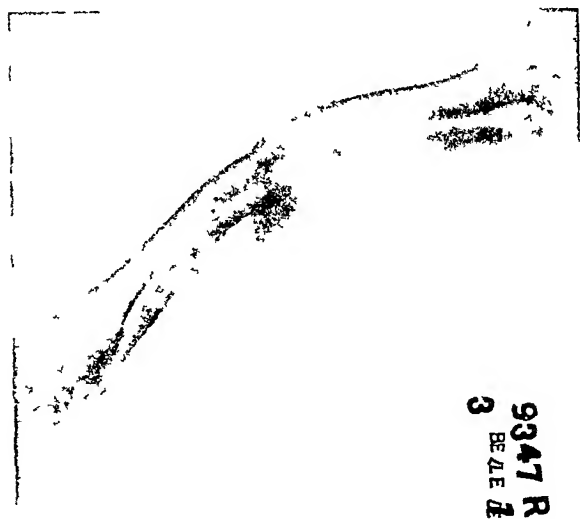


FIG. 5. Following correction of deformity of right leg in Case IX.

marked tenderness and angulation at the point of fracture, and a roentgenogram showed fracture of the upper and middle third of the left femur. Traction was applied and the fracture healed rapidly. The patient presented the characteristic blue sclera and the mother states that the first fracture occurred at nine months of age. Since this time the child has had innumerable fractures. There was no history of a similar condition in the family. The patient was referred after the fracture healed to a convalescent home for care and observation.

CASE IV. M. K., a female child, five years of age, entered the clinic at the Hospital for Ruptured and Crippled on July 1924 for opinion regarding deformities of the humeri and femora. The mother stated that at birth the child presented a number of fractures of the long bones of the body. No family history was available and the last examination showed a child of small stature, able to walk but presenting malunion of both humeri and femora from previous fractures, with intensely blue sclera. No recent data on this case are available.

CASE V. H. C., a child three days old, was brought to the clinic at the Hospital for Ruptured and Crippled in June, 1930, because of multiple deformities of the long bones. The child presented characteristic blue sclera, marked anterior bowing of the



FIG. 6. Anterior bowing of left leg in Case IX.

of the bones. The patient did not return for further observation.

CASE VI. J. M., a female child eight months of age, was brought to the clinic at the Hospital for Ruptured and Crippled. There was no family history of a similar condition. This child was the mother's first pregnancy, with normal delivery, and presented marked hydrocephalus with fracture of the femora and humeri, and intensely blue sclera. The patient was referred to an institution for care and observation.

CASE VII. A. S., a girl ten years of age, was referred to me on August 15, 1922, on account of a fracture of the upper third of the left femur, caused by falling and striking the left thigh against the pavement. The patient complained of very little pain at the site of fracture and the fracture healed rapidly. The mother stated that the child had had 26 fractures of the various long bones of the body, but that there was no family history of a similar condition. The child presented blue sclera. After the fracture healed the patient returned to her home in Toronto, and I am indebted to her physician, Dr. R. I. Harris, for a recent report on the case. He states that she has had no recent fractures, but presents multiple deformities, and further fractures are prevented only by the patient leading a very guarded life.

CASE VIII. A. K., a woman twenty-two years of age, returned in answer to a follow-up letter and was seen at the Hospital for Rup-



FIG. 7. Following operation on left leg with correction of anterior bowing. Solid bony union, but note paucity of callus in bone healing, characteristic of these older, arrested cases, Case ix.

tured and Crippled in April, 1924. She walked without assistance, was of small stature, with bowing of the tibiae and femora, and a marked right dorsolumbar scoliosis. She stated that she had had many fractures of the upper and lower extremities, including both clavicles, but that the last fracture had occurred a number of years ago. The patient presented characteristic blue sclera of rather darker blue hue than seen in those cases in which the process was active. She is able to walk about but her deformities interfere with her leading an active life.

CASE IX. A. M., a woman twenty-five years of age, came to the University and Bellevue Hospital Medical College clinic on February 24, 1930, on account of deformities of both legs. She stated that within the first year of life she suffered several fractures of her long bones, and during the first ten years of

her life had approximately 100 fractures, each occurring very easily so that her bones were thought to be "like glass." For the past ten years patient has suffered no fractures but presents severe deformities as the result of malunion of the long bones. Careful questioning failed to reveal any history of blue sclera or bone fragility in any other member of the family. Patient was 45" tall, presented a short trunk, marked outward bowing of the femora, and anterior bowing of the tibiae. She walked awkwardly but was able to walk unsupported. The upper extremities showed negative symptoms. The sclera of the eyes were remarkably blue but of distinctly darker hue than that noted in the younger cases. A blood chemistry examination was made and both calcium and phosphorus content were within normal limits. The patient was quite deaf and stated that she had noticed increasing deafness which had slowly developed in the last ten years. Both ears appeared to be equally affected. Otoscopic examination was negative.

The patient was admitted to Bellevue Hospital and on September 8, 1930, a wedge osteotomy was done on the left tibia, the fibula being manually fractured. The bone was found very hard, the cortex much thickened, and the shape of the bone remarkably changed. The lateral diameter measured about $\frac{1}{2}$ inch at its thickest portion, and tapered to about $\frac{1}{8}$ inch at its thinnest portion. There was a moderate amount of bleeding from the bone. The wound was closed without drain and a plaster bandage applied from the toes to the groin, with the anterior bowing well corrected. On November 28, 1930, a similar osteotomy was done on the right side with similar findings. This healed without any excess callus, as shown in Figures 5 to 7. Union occurred slowly and support was continued for four months, at the end of which time the patient was allowed to begin weight-bearing. At present she is walking about without any support and with the anterior bowing corrected to the degree shown in the recent roentgenograms.

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IMPROVED BONE CLAMP*

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DAVENPORT, IOWA

IN open reduction of fractures our most difficult problem has been the retention of bone fragments in proper alignment

side out of the way of the operator while he places his bone plate or graft. The jaws are high enough so that in deep-seated frac-

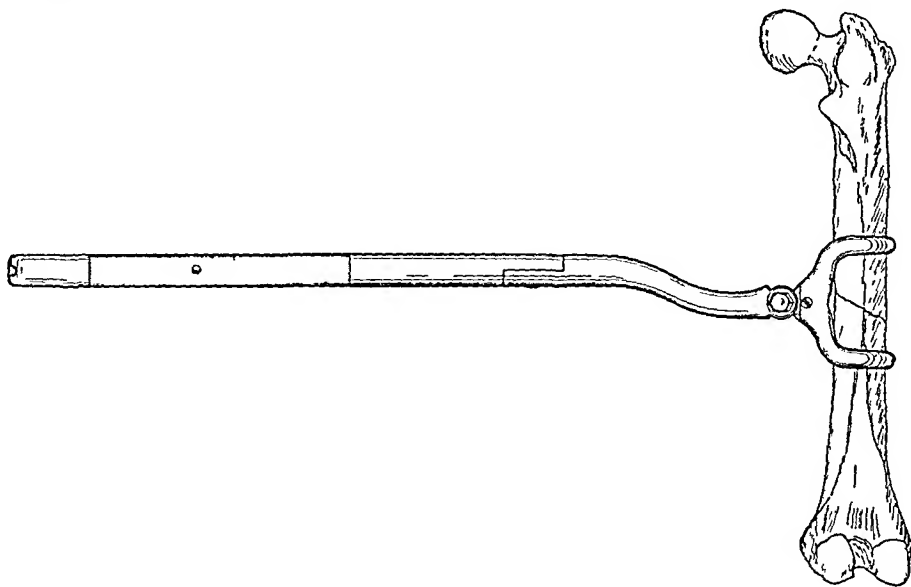


FIG 1.

while fixation is made by plates, screws, grafts, etc., and this through the fact that the bone clamps devised lack in one or more features complete adaptability to this work.

One familiar with this work realizes how frequently his bone clamps will not be adjustable to the fracture involved or will not hold the fracture in proper alignment, or perhaps after adjustment and alignment the instrument is so cumbersome as to be obstructive in placing the plate or graft.

To overcome these difficulties the following instrument has been devised, and by the aid of the accompanying plates, it will be readily seen that the technique of open reduction has been facilitated.

The clamp consists of a pair of jaws adjustable to a lock handle forceps and a universal joint so that after being applied, the handle can be pushed over to either

tures the handle is permitted to rest out of the way, which is a distinct advantage.

Figure 1 shows clamp applied to a reduced fracture.

In Figures 2 and 3, the handle has been placed to either side as desired.

Figure 4 is then seen looking down on the clamp and fracture from the top, illustrating how much more conveniently fixation material may be applied.

The jaws of the clamp, in addition to being hinged, have a swivel lock, permitting adjustment laterally as illustrated in Figure 5. This permits their use at the expanded ends of long bones or wherever the contours of the bone do not run parallel.

Figure 6 A, B, C illustrates the interchangeable jaws and key.

In conclusion I want to state that by the use of the new bone clamp many undesirable operative difficulties can be eliminated.

* Submitted for publication December 15, 1931.

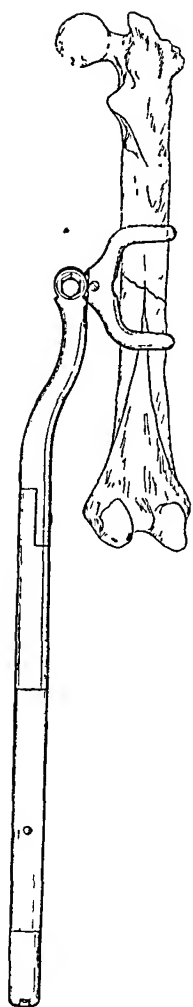


FIG. 2.

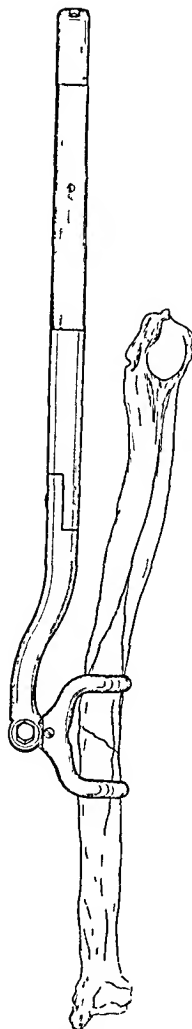


FIG. 3.

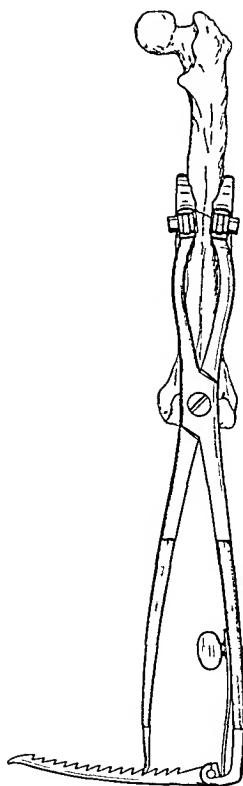


FIG. 4.

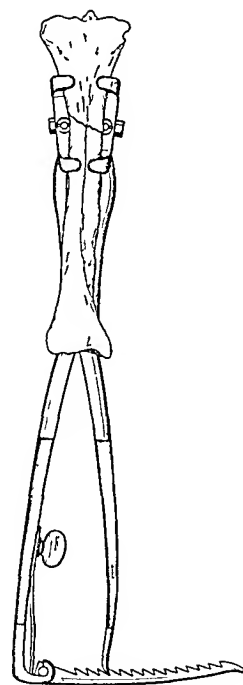
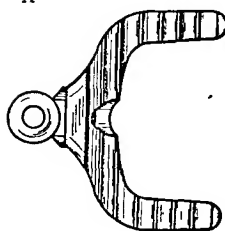


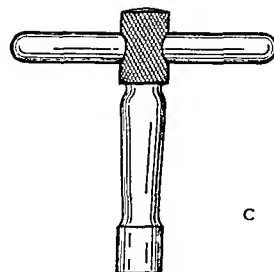
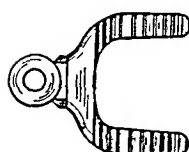
FIG. 5.



A



B



C



FIG. 6.

AN IMPROVED EXTENSION APPARATUS FOR SKELETAL TRACTION*

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DAVENPORT, IOWA

IT has been the writer's experience that there are two very important factors to be considered in the treatment of

price. With these ideas in view the author devised and simplified the Kirschner clamps and instruments.

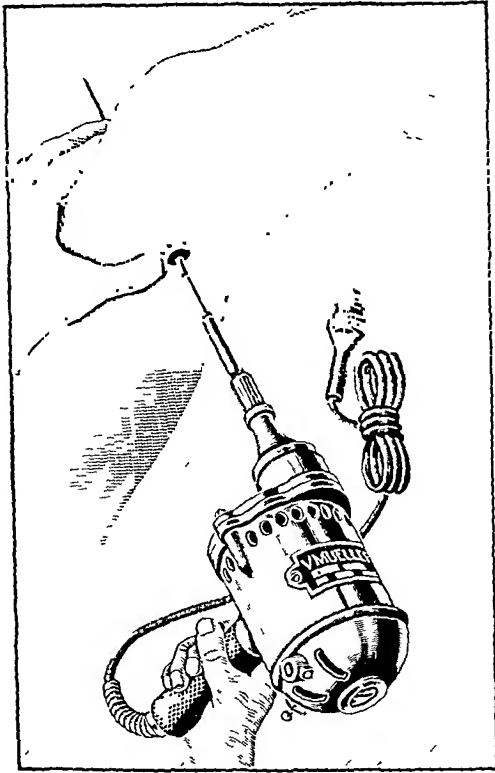


FIG. 1.

fractures; namely, restoration of function and anatomical alignment.

The anatomical reposition of a fracture must be accomplished by manipulation, and after reduction must be held in place by traction during part or all of the healing period. Various methods of extension have been tried and applied but the one recommended by Kirschner fulfills the purpose better than any other.

In order to accomplish these results the surgeon must possess certain instruments and armamentarium which are simple in construction and not prohibitive in

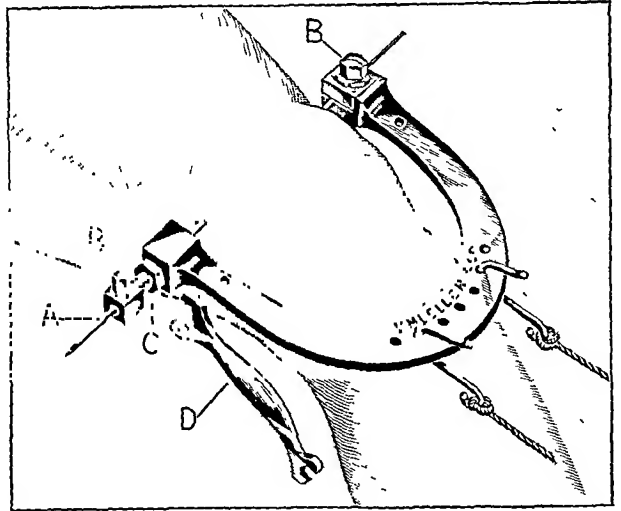


FIG. 2.

To the author's special motor is attached a telescope supporting apparatus which holds the extension wire as illustrated in Figure 1.

After the wire has been introduced through the bone it is placed in the traction bow and the necessary tension put on the wire by a very simple extension bolt as illustrated in Figure 2, point C. The tension on the wire is made by means of the wrench D at point C; after the desired traction has been made it is fixed at points B.

Figure 3 shows author's complete motor set including wire and telescope supporting apparatus (the telescope supporting apparatus can be fitted for other type of motor).

Figure 4 shows author's complete set of simplified extension bows.

In conclusion the author wishes to state that the Kirschner method if properly used, in certain groups of cases, will greatly assist the surgeon in the alignment of his fractures, which will spell better functional end results.

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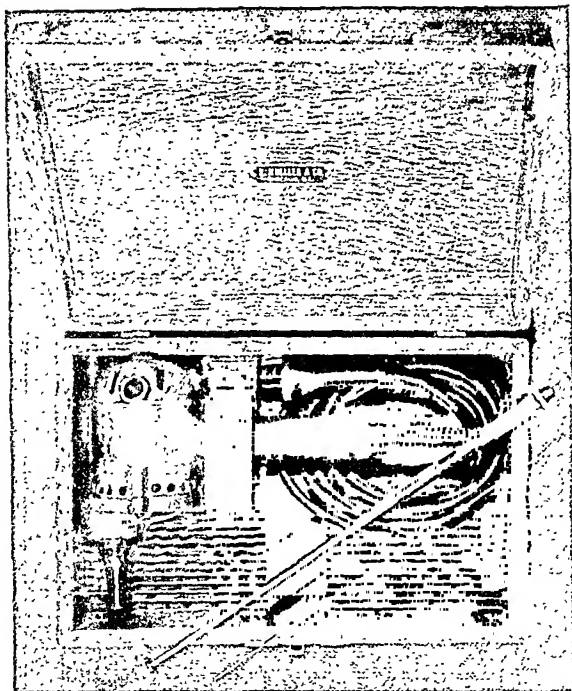


FIG. 3.

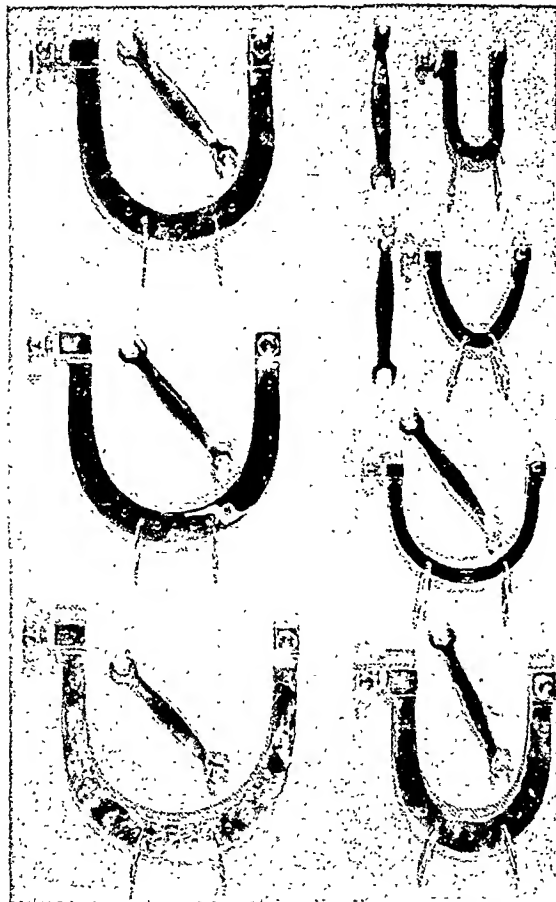


FIG. 4.



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* Continued from p. 340.

CLINICAL MANAGEMENT OF THE HORSESHOE KIDNEY

PART III (CONCLUSION)*

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X. REPORT OF CASES

Summary of 19 Cases of Horseshoe Kidney Disease with Preoperative Diagnosis

CASE 1. D. S., aged eighteen, male, hospital No. 282,425 admitted Oct. 15, 1928.

Résumé of Symptoms: Patient is a thin, well developed young man but very anemic, lying in bed and acutely ill, complaining chiefly of pain in epigastrium and umbilical region, marked frequency of urination and nocturia, dysuria, pyuria, nausea, vomiting, headache and high temperature. Duration three weeks. He had been treated for persistent chills and fever of undetermined origin, until he came under my observation. On physical examination the abdomen is much contracted and rigid, both kidney regions tender and painful on palpation. Patient stated that attacks of intermittent pain have occurred for several years and chronic constipation has been present from birth. He claims that he has been using enemas daily, from childhood, and his bowel troubles have been accompanied by persistent pain in the umbilical region and across his back which has made him unfit to work or to attend to his duties at school.

Cystoscopic Findings and Functional Renal Tests: Bladder mucosa chronically inflamed, multiple cellules and trabeculations. Both ureteric orifices markedly congested and interureteric ridge of trigone markedly hypertrophied. Both ureters catheterized. Phenolsulphonephthalein appeared on right side in two and one-half minutes, on left in ten minutes. Urine from bladder foul and purulent. Urine culture negative.

Roentgenography: No shadow indicative of stone in urinary tract. The shadow of the right kidney is irregular and low in position, about the level of the fourth lumbar vertebra, and there is an indefinite shadow, suggesting the isthmus of a horseshoe kidney.

Urographic Findings: Right pyelogram, moderate degree of hydronephrosis; pelvis is turned and the calices point inward toward the spinal column. Left pyelogram, slight hydronephrosis with rotation of pelvis and calices, which point inward.

Diagnosis and Type of Lesion: Horseshoe kidney with bilateral hydronephrosis and pyelonephrosis infection plus pyelitis and pyelonephritis.

* Part I appeared in the December, 1931 issue, vol. 14, p. 657, and Part II in the January, 1932, issue, vol. 15, p. 132.

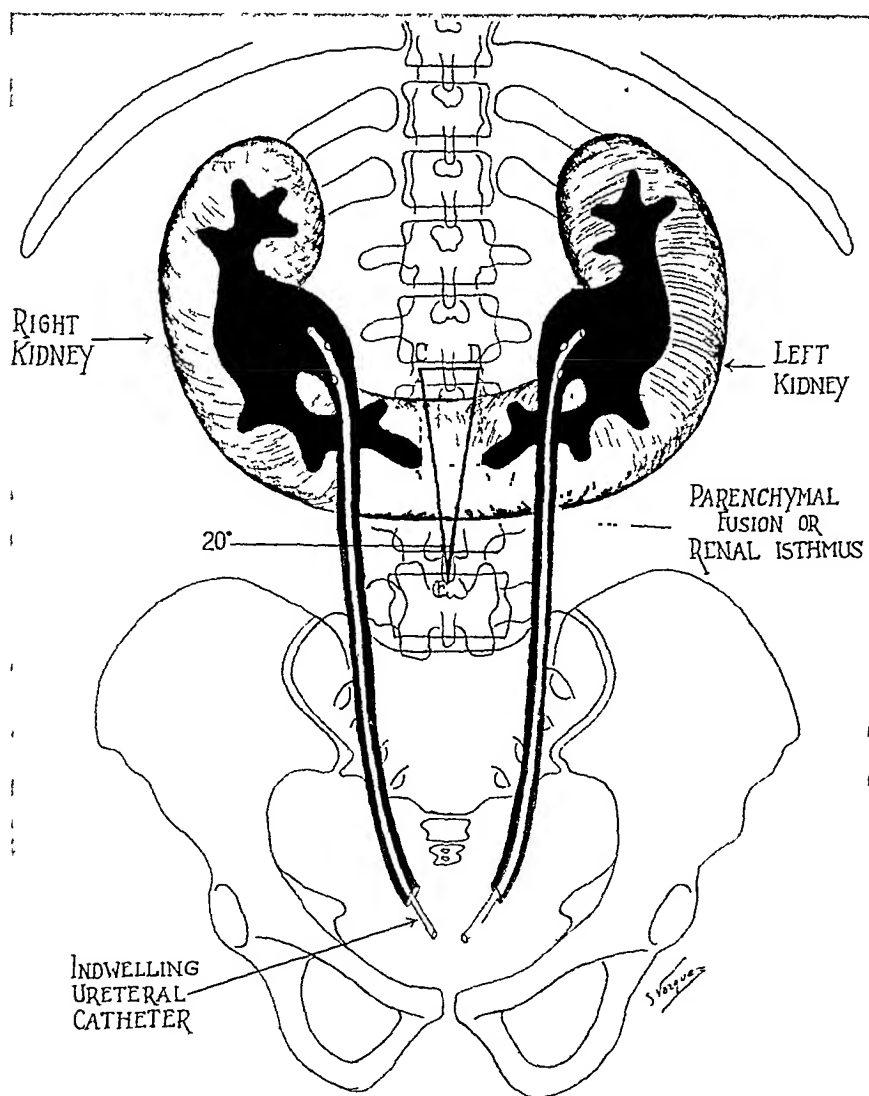


FIG. 41. Drawing made from Case 1 to illustrate the value of the medical and urological treatment in acute cases of horseshoe kidney disease with evidence of urinary stasis, pyelitis and pyelonephritis, particularly when using the method of the indwelling ureteral catheter to secure drainage, to relieve pain and infection and to prevent fatal uremia. Note also the presence of the *minimum basal angle of the pyelographic triangle of the horseshoe kidney.*

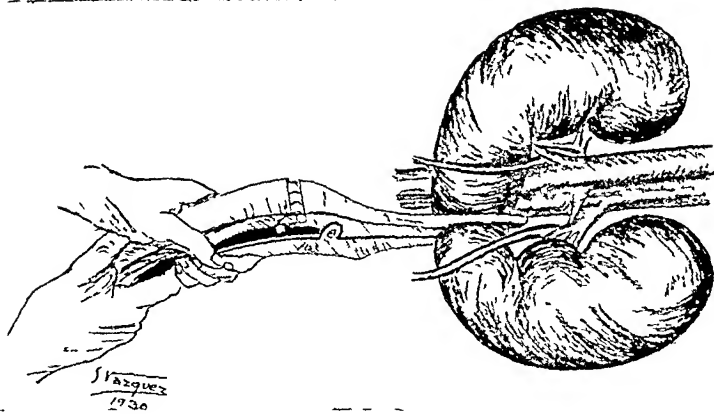


FIG. 42. Represents the first step in the operation of renal symphysiotomy for division of the parenchymal isthmus in horseshoe kidney disease.

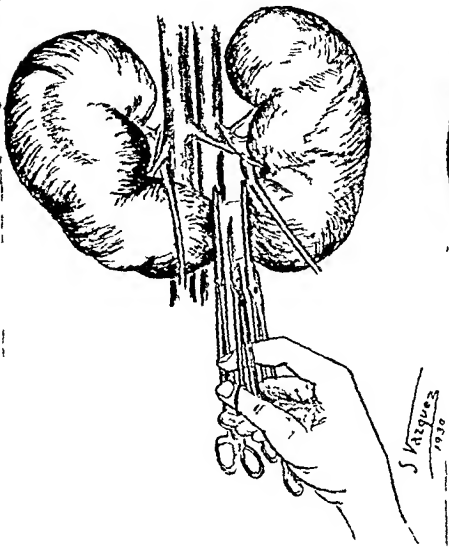


FIG. 43.

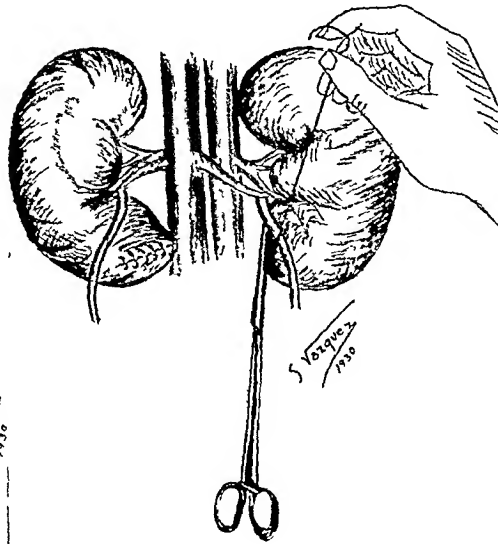


FIG 44

FIG. 43. Illustrates the second step of the operation of renal symphysiotomy in normal horseshoe kidney as the only possible means of obtaining permanent relief from symptoms and ultimate cure.

FIG. 44. Represents the final step in the technique of the renal symphysiotomy operation, which consists of separation of the two kidneys from their incarcerated position upon the aorta and vena cava, followed by suture of the raw surfaces of the cut renal isthmus. This operation appears to be the ideal method of treating the entity of horseshoe kidney disease. (Redrawn from Rovsing's case.)

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Pathological Observations: At times uremic with temperature up to 104°F. Pulse very irregular and rapid. Difficulty in breathing and in precordial region. Persistent pain in epigastrium, rigidity of abdominal muscles and vomiting. General weakness, poor circulation of extremities with edema and cyanosis of both legs.

Treatment: Medical: Urinary antiseptics, urotropin and sodium acid phosphate, *t.i.d.* Intravenous infusion of saline solution, cathartics and high colonic irrigations, forced fluid, rest in bed, heat to kidneys and extremities, etc. *Urological:* Indwelling ureteral catheters to secure drainage and relieve pressure; kidney pelvis irrigations with acriflavine 1:10,000 to correct infection and prevent inhibition of kidney function. *Surgical:* None.

Results and Observations: Left hospital in two weeks, apparently cured of acute symptoms. Two months later still complained of pain in epigastrium and in both kidney regions. Urine hazy and never free from pus. Patient is thin, abdomen much contracted; still complains of chronic constipation for which he uses enemas daily and cathartics. Cystoscopic treatments, with dilatation of ureters and kidney pelvis lavage, have been carried out on various occasions and relieved the symptoms somewhat, but patient states that while he is feeling much better he is not entirely well, and that the cause of his trouble has never been explained to him before. Symphysiotomy operation proposed but in view of his improvement the patient went South and no further data have been obtained.

CASE II. B. C., aged twenty-nine, male, hospital No. 284,810, date of admission Feb. 23, 1929.

Résumé of Symptoms: Burning on urination, pain on left side, duration five days. Hematuria and pyuria. Occasional rise of temperature and chills.

Cystoscopic Findings and Functional Renal Tests: Interior of bladder negative. Both ureters catheterized without obstruction. Phenolsulphonephthalein on left side in nine minutes, on right no appearance. Urine culture negative.

Roentgenography: No shadow indicative of stone in urinary tract. Shadow of left kidney much larger and lower than that of right.

Urographic Findings: Right pyelogram shows a typical arrangement of the calices of a horseshoe kidney. Left pyelogram shows complete excavation of the left kidney, with infectious hydronephrosis.

Diagnosis and Type of Lesion: Horseshoe kidney with bilateral pyelonephritic infection and left hydronephrosis.

Pathological Observations: High temperature, severe pain in epigastrium, at times uremic symptoms.

Treatment: Medical: Urinary antiseptics. *Urological:* Indwelling ureteral catheters with kidney pelvis irrigations. *Surgical:* None.

Results and Observations: Improved, and discharged March 30, 1929.

CASE III. M. D., aged twenty-one, male, hospital No. 175,268, date of admission May 5, 1930.

Résumé of Symptoms: Pain in lower right quadrant, also slight pain in umbilical region. Slight frequency and dysuria. Patient entered hospital with a provisional diagnosis of appendicitis.

Cystoscopic Findings and Functional Renal Tests: Bladder chronically inflamed throughout. Both ureters catheterized but catheter met obstruction on right side about 2 cm. from ureteral orifice. Phenolsulphonephthalein appeared on right side in seven minutes, on left side in three minutes. Culture of urine showed negative growth.

Roentgenography: Left kidney shadow is lower and larger than that on the right and the actual lower poles of both kidneys are not seen. There is a small shadow in contact with the catheter just opposite the third sacral foramen on the right side, revealing the presence of a small stone impacted in the lower ureter.

Urographic Findings: Bilateral pyelograms taken on April 28, 1930, reveal horseshoe kidney. Also later, on May 13, 1930, uroselectan pictures, twenty minutes after intravenous injection, showed a beautiful shadow of the entire urinary tract and the calices of both pelves pointing towards the median line. A filling defect of a round calculus was seen in the lower end of the right ureter.

Diagnosis and Type of Lesion: Horseshoe kidney, bilateral pyelitis, calculus in right lower ureter.

Pathological Observations: At times severe attacks of pain in right lower quadrant and umbilical region with rise of temperature.

Treatment: Medical: Urinary antiseptics, rest in bed, cathartics and forced fluid.

Urological: Cystoscopy, dilatation of ureters, lavage of kidney pelvis with revonol dextrose 1:5000. Indwelling ureteral catheter at times.

Surgical: None.

Results and Observations: Patient left hospital after four weeks with the diagnosis just given and feeling better, but in still receiving cystoscopic treatment. His general condition is improved.

CASE IV. J. T., aged fifty, male, examined Dec. 20, 1926; presented here by courtesy of Dr. Hernandez of Havana. Chief complaint, pain in epigastrium for over twenty years, gastric trouble for several years. Pain in both renal regions with dysuria and intermittent attacks of hematuria.

Physical examination revealed that both kidneys were painful on palpation of abdomen, and a definite tumor mass was easily made out on the left side which apparently ran across to the opposite side where another definite hard tumor mass was also palpable. Urine analysis showed microscopic pyuria and hematuria and a trace of albumin and casts. January 2, 1927, a plain x-ray revealed the presence of a gigantic bilateral renal calculus occupying the entire site of both kidney pelves. On the right side there were two unusually placed shadows about the size of a lime, quite close to the spinal column at the level of the third and fourth lumbar vertebrae and near the midline. On the left side the shadow of the coraliform stone which was about the size of an orange, occupied the entire area of the left kidney pelvis and appeared to be rotated inward with the calices or branches of the stone pointing to the spinal column. A definite diagnosis of horseshoe kidney with bilateral nephrolithiasis could be made from the plain x-ray pictures.

Patient was cystoscoped January 13, 1927, and a right pyelogram taken, confirming the diagnosis of horseshoe kidney with bilateral renal stone and marked diminution of renal function. Blood chemistry figures at that time were pretty high, and in view of patient's general unsatisfactory condition palliative treatment alone was recommended.

CASE V. W. L., aged fifty, male, hospital No. 269,959; a well developed individual with blood pressure 120/92, admitted to the Urological Department of New York Hospital Nov. 10, 1926. Patient came to the clinic complaining of pain in both kidney regions and in bladder of over thirty years' duration, but more severe for the last two months during which it has been accompanied by frequency of urination, dysuria and changing flow of urine. He also had an attack of acute retention for which he entered the hospital.

For the past ten years he has been having a great deal of trouble physically and has had medical treatment for neurasthenia and general bodily weakness, also prostatic

massage and bladder irrigations. Fifteen years ago he had a perineal operation for drainage of seminal vesicles and three months ago an abdominal operation in another hospital at which horseshoe kidney was discovered but no relief of abdominal pain obtained.

Physical examination revealed a large scar at the left side of the abdomen with slight tenderness on deep pressure. There was suprapubic dullness extending to the umbilicus. Rectal examination disclosed an enlarged prostate, leading to a diagnosis of hypertrophy of prostate with complicating phlebitis and chronic cystitis, for which a suprapubic cystotomy was done Nov. 16, 1926.

Patient was discharged from hospital January 19, 1927, with a suprapubic drainage tube and with his general condition improved; readmitted to hospital March 4, 1927, complaining of marked pain in the abdomen and bladder region, with slight fever; he was carrying a suprapubic Pezzer catheter which was not working satisfactorily. This was replaced by a double suction tube, and a Young punch operation under regional anesthesia was planned to be carried out as soon as the general condition should warrant it. The patient was discharged and advised to return to the hospital after a period of convalescence when perineal prostatectomy was also to be considered.

Nov. 10, 1926, cystoscopy revealed a normal bladder mucosa except for marked congestion of the trigone, considerable intrusion of the subcervical group and moderate infringement of the lateral part of the prostate. Both ureters were catheterized and the renal function was found about equal on both sides. The roentgenogram revealed the shadow of the left kidney larger than usual, giving the impression of polycystic kidney disease. In the left pyelogram, the kidney was unusual in shape and turned inward, giving a definite impression of an infected horseshoe kidney. The second admission was on March 4, 1927, and the discharge on March 11, 1927, with the result unimproved. No further surgical treatment was carried out and two weeks later patient died of pneumonia. No autopsy was secured.

CASE VI. B. L., housewife, aged forty-three, hospital No. 269,385, Russian, admitted to New York Hospital Oct. 6, 1926, with diagnosis of chronic constipation and pain in lower abdomen for over two years. An operation in some other hospital for chronic appendicitis had brought no relief. Patient is married and has four children, living and well. She has been suffering with occasional attacks of dull, recurring pain in right lower quadrant of abdomen, for a period of nearly twelve years, which at times radiated across abdomen and around the back on both sides. For the last two years since the appendectomy operation, pain has been constantly present in varying degrees, at times fairly severe. It has been slightly more marked in the morning following a night's rest, and has sometimes been relieved by enemas and morphine. During the past few months the pain has gradually become worse.

For past year and a half patient has been compelled to take daily enemas. She stated she had been constipated all her life but never to such a marked degree as now.

For the last six months there has been slight gastric trouble with marked gaseous eructations and meteorism, but no vomiting or pain after meals.

The menstrual history has always been regular except that in the past year patient has had "severe pain" throughout duration of menstrual periods.

Urine analysis has always been negative. But during past six months patient has had a very noticeable polyuria, with frequency during day of ten to fifteen times, and during night of two to three times. No pyuria or hematuria has been present at any time. Physical examination was essentially uninteresting. All sorts of examination in general hospital had been undertaken in order to find a possible cause of her symptoms but she was discharged Oct. 16, 1926, with the diagnosis of chronic constipation and

indefinite colon pathology, and with the results of improvement. Patient was readmitted to the hospital Nov. 14, 1927, with the same complaint. But the undetermined abdominal pain, particularly in the umbilical region, has been more severe, and she has also developed rectal tenesmus, for which proctoscopic examination was carried out but proved negative. X-ray with barium enema and barium meals did not disclose a true pathology in the colon or gastrointestinal tract. As the patient had pollakiuria and dysuria and pus cells in the urine, she was referred to the urological department for cystoscopic examination. Cystoscopy Oct. 14, 1926, revealed a normal bladder except for an unusual mucosa that was folded over itself with marked trabeculations and cellulules. Both ureters were catheterized and renal function found to be normal. The left pyelogram, however, revealed a rotated kidney pelvis with shaggy and dilated calices, giving the impression of horseshoe kidney as the definite cause of her trouble. A diagnosis of horseshoe kidney with pyelonephritis was accordingly made and patient was discharged improved Nov. 18, 1927, after a few cystoscopic treatments and kidney pelvis lavage.

CASE VII. M. S., aged thirty-two, male, examined by Dr. Hernandez of Havana May 25, 1926. Chief complaint renal colic and gastric trouble on different occasions; also pollakiuria, dysuria and pain in both kidney regions and in epigastrium, on deep palpation.

Physical examination and urinalysis negative. Roentgenography disclosed the presence of shadows of a urinary calculus in the area of the pelvis and calices of the right kidney. Cystoscopy May 30, 1926, revealed a diffused cystitis and a good renal function. Right pyelogram showed that the opaque medium obscured the original shadows of stone and that the pelvis was rotated with calices reversed and pointing toward the spinal column, thus revealing the diagnosis of horseshoe kidney with stone in the right side. The right kidney was exposed and heminephrectomy done. Patient had an uneventful convalescence.

CASE VIII. A. M., aged twenty-six, female, has been complaining for several years of chronic appendicitis with indefinite pain on the right lower quadrant. Also has pain across her back.

Cystoscopy on June 7, 1929, revealed two ureteral orifices on the left side and one opening normally on the right side of the trigone. The three ureters were catheterized and specimens collected and sent to the laboratory for culture, and for urea and microscopical examination. Phenolsulphonephthalein 1 c.c. injected intravenously appeared from the three ureters in three to four minutes with normal concentration. The culture of urine was negative. Roentgenography revealed no shadow indicative of stone in the urinary tract. The right pyelogram showed infection of two parts of the double pelvis with a very peculiar arrangement of both the pelvises and the calices, giving the impression that the two pelvises reached the common ureter and that the whole organ was rotated inward as in horseshoe kidney. A week later a pyelogram of the two ureters and two corresponding kidney pelvises on the left side revealed also the fact that these were rotated toward the spinal column and thus confirmed the presence of a congenital anomaly of four pelvises and four incomplete ureters in a horseshoe kidney. Since this diagnosis has been established, the treatment carried out has been the routine cystoscopy, dilatation of the ureters and kidney pelvis lavage, which brings relief and very satisfactory results in clearing up the pyelonephritic infection. The microscopical examination of sediment has shown that the urine collected from each kidney pelvis contains occasional pus cells, epithelial cells and many red blood cells. The culture of the urine from the bladder and from each kidney pelvis has at all times been negative. Apparently patient is improving under the routine urological treatments.

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CASE IX. M. K., aged fifty-eight, female, had always been in good health, but complained of slight backache for the last ten years. In the last few months she has noticed frequency and painful urination, for which cystoscopy was performed, revealing a normal bladder with ureteral orifice slightly congested, as were also the trigone and vesical orifice. The ureters were catheterized with a No. 6 French catheter. The renal function was good from both sides. Bilateral pyelogram on March 14, 1929, revealed a peculiar shape of pelvis with marked rotation and the calices opening toward the midline. The ureters were somewhat distorted and dilated but apparently fell within normal limits. They reached the pelvis in a peculiar and abnormal angle, their direction alongside of the spinal column making a wide-mouthed "flower vase" figure as if approaching each other above and carrying the contents of a horseshoe kidney. After the diagnosis was established, patient was submitted to cystoscopic treatment with dilatation of the ureters and kidney pelvis injection with a solution of revonol dextrose 1:2000. In addition, because the position of her kidney shadow was lower than normal, she was given a kidney belt to support the organ. While her general condition has improved, her symptoms have not entirely disappeared. It seems, therefore, that no definite cure or relief of symptoms can be obtained until the isthmus of the horseshoe kidney is divided by the symphysiotomy operation, separating the fused organ into two separate organs, and thus relieving the continuous pressure that the isthmus of the horseshoe kidney exerts upon the aorta and vena cava and upon the nerve supply of the same.

CASE X. F. L., male, Italian, aged thirty-two, hospital No. 274,340, was admitted into the Urological Department of the New York Hospital July 21, 1927, complaining of swelling of left testicle of three and one-half years' duration, also dysuria and frequency. Patient states that in the past he has had attacks of renal colic, frequency, hematuria and intermittent pain in right lumbar region. He further states that an operation was done in Italy fourteen years ago for the removal of stone from the right kidney, since which time he has been suffering with abdominal pain. The diagnosis made was left chronic epididymitis and left seminal vesiculitis, and on July 22, 1927, under local anesthesia left epididymectomy was done for a tuberculous epididymis. The vas deferens was transplanted to the surface of the skin about 1 in. below Poupart's ligament and above the external inguinal ring. Patient made an uneventful recovery and was discharged from the hospital on July 30, 1927. The laboratory report of the specimen proved that the epididymitis was of a tuberculous nature. Patient was readmitted to the urological service on Sept. 9, 1929, with swelling of right side of scrotum of over four months' duration. A right hydrocele with a chronic right tuberculous epididymitis was diagnosed, for which he was operated upon on Sept. 10 under local anesthesia. Right hydrocelectomy and epididymectomy were carried out in the usual manner. Again patient had an uneventful recovery and was discharged Sept. 19, 1929. Two weeks later he came back complaining of pain on the upper right quadrant where he had the scar of a previous kidney operation. Cystoscopy was done, and a plain roentgenogram and a right pyelogram taken, revealing that the right and left kidney shadows were indefinite but appeared to be low in position, giving the impression of a union between the two kidneys in the midline. The pyelogram thus indicated the presence of a horseshoe kidney with an excavation of the right pelvis and the presence of a pyohydronephrosis presumably of tuberculous origin and representing the primary focus of tuberculous infection of long standing. The calices were shaggy, distorted and dilated, the lowermost ones pointing inward toward the midline, thus confirming a definite diagnosis of horseshoe kidney. No further operation was considered in this case and the patient has been receiving the

usual anti-tuberculous treatment in the postoperative tuberculosis clinic of the hospital with the diagnosis of renal tuberculosis on the right side of a horseshoe kidney.

CASE XI. G. P., history No. 273,151, merchant, thirty-five years of age, admitted May 16, 1927, complaining of pain in left lumbar region of over four years' duration; had been operated on elsewhere for appendicitis, but indefinite pain in the umbilical region persisted after appendectomy. Had experienced a severe attack of pain on left side with marked urinary disturbances six weeks previous to admission to hospital. Cystoscopy and left pyelography were done and plain x-ray pictures of the genitourinary tract also taken. The latter showed a round shadow opposite the transverse process of the fourth lumbar vertebra on the left side, disclosing further the presence of a stone at the level of the left ureteropelvic junction. The kidney shadows on both sides were particularly interesting in that they were apparently connected by an isthmus at the lower pole, forming a typical horseshoe kidney. The left pyelogram showed a bifid pelvis, with the calices of the upper portion of the kidney dilated and shaggy, pointing backward and laterally, while those of the lower portion pointed markedly inward toward the spinal column, thereby revealing the presence of a horseshoe kidney with infection and stone in the ureteropelvic junction on the left side. The patient was advised to have dilatation of ureters and kidney pelvis lavage, in an attempt to allow the stone to pass and to overcome the infection. The renal function on each side was sufficient in regard to urea excretion and phenolsulphonephthalein elimination. Microscopical examination of sediment showed pus cells 20 per field on the left, and blood and epithelial cells 3 per field on the right. After several cystoscopic treatments, the stone moved down into the intra mural vesical portion of the ureter and was removed from the left ureteral orifice with the Lowsley irrigating rongeur. Patient was discharged from the hospital two days later as improved but with the diagnosis of horseshoe kidney.

CASE XII. J. de R., male, Italian, aged twenty-two, History No. 262,783. Student by occupation, well nourished and well developed but appearing acutely ill on August 27, 1925, when he was admitted to hospital, his chief complaint being pain in left kidney region and severe pain in rectum.

Physical examination revealed a very rigid and contracted abdomen. Blood pressure systolic 210, diastolic 110. Patient was brought to hospital on the theory that the severe pain in left kidney region was due to a ureteral obstruction from an impacted stone in the pelvic ureter. Blood chemistry showed urea retention up to 167.90, thus revealing the critical condition of the patient, who was uremic and unconscious. Twelve years ago a stone had been removed from the bladder by cystoscopic manipulations. Eighteen months previous to admission to the urological department patient had undergone an operation for appendectomy elsewhere. A relative stated that at the time of the appendectomy the surgeon had told him that the patient had an enormous kidney (?). On August 28, 1925, the patient was cystoscoped. A considerable amount of cloudy and foul urine was removed from his bladder, and after a profuse washing the bladder mucosa appeared very much injected throughout, containing many particles of pus on its surface. There was a bulging at the vertex of the bladder, apparently due to some external pressure. No stones, tumor masses, diverticula or ulcerations were seen in the urinary bladder. Both ureters were catheterized and a left pyelogram was taken, about 15 c.c. of sodium iodide being injected into the left kidney pelvis. After the picture was taken the catheter was reinserted, the sodium iodide allowed to drain off, the kidney pelvis irrigated with sterile water, and the instruments and catheters removed. Patient was sent to ward in fair condition. The pyelogram revealed an unusual shape of pelvis which at first was thought to indicate a polycystic kidney, but in view of the fact that the

pelvis was rotated and that the calices were inverted, pointing toward the vertebral column, a diagnosis of horseshoe kidney was made. The patient's general condition appeared to be better for a day or so, but on Sept. 3, 1925, it became aggravated, with a high temperature and the blood urea rising as high as 261.28. Despite every care and attention patient died on Sept. 6, 1925, from acute uremia due to an infected horseshoe kidney condition.

CASE XIII. A. B., a Russian woman, aged twenty-four, admitted to medical division of the New York Hospital and later on January 17, 1927, transferred to Urological Department, history No. 271,004. She had been complaining of severe pain in both kidney regions with intermittent attacks of hematuria and pyuria over a period of several years, accompanied with burning and difficulty of urination, which symptoms have become aggravated in the last two weeks. She has also been suffering with marked chronic constipation all her life. On physical examination the abdomen was very much contracted and there was definite pain on palpation in the umbilical region and also on the right lower quadrant. Patient was cystoscoped and a right and left pyelogram taken revealing the presence of a rotated pelvis irregular in shape, with the lower calices pointing inward toward the midline thus demonstrating the presence of an infected horseshoe kidney. Three days after admission she became suddenly hysterical and delirious, and developed a mental complex for which she was transferred to Bellevue Hospital for further observation and treatment. No further information has been recorded in this case.

CASE XIV. J. R., male, aged forty-four, admitted to the clinic of the Urological Department of the New York Hospital on Jan. 14, 1930, history No. 172,381. Although appearing in good health, he stated that he had been receiving medical attention for the last fourteen years for various conditions for which he had been treated in several hospitals. These conditions according to his statements have been arthritis, rheumatic pain, stomach trouble and also ulcer of the stomach. He also stated that so far no treatment has relieved his complaint and that he came to the clinic of the New York Hospital mainly because of difficulty and frequency of urination and indefinite pain in upper abdomen. A careful history and check up in connection with this series of horseshoe kidney cases have revealed very striking clinical evidence of this longstanding disease.

Chief Complaints: (1) Pain in epigastrium and umbilical region of two years' duration.

(2) Pain on left leg with edema of right foot and sensation of cold, due probably to lack of circulation.

(3) Marked chronic constipation. Patient has had to have a daily enema and laxatives every other day for the last two years.

(4) Gastric trouble, sensation of fullness, gastrointestinal disorders. Patient claims that other doctors have told him he has ulcer of the stomach, but he has good appetite and has lost neither blood nor weight.

(5) Difficulty and frequency of urination, marked dribbling. Nocturia two to three times.

(6) Attack of right renal colic one year ago but never has had hematuria.

(7) Persistent pus in urine and sometimes dysuria.

Family History: Patient born in Russia, has one sister and 12 brothers, 2 of whom are twins. Father is eighty-six years old, living and in good health. Mother died twenty-one years ago of pain in the middle of the abdomen and probably same sort of kidney trouble as that of which patient is complaining.

Personal History: Patient has had the ordinary childhood diseases without incidents. The first clinical manifestations of the present trouble started twenty-three years ago after he had been in the military service abroad. During a long stretch of walking, he was

seized with a sudden attack of pain in the middle of the abdomen. There was also pain in the right leg with a sensation of cold in the same, which made it impossible for him to continue in the army. The second attack of clinical manifestations appeared again fourteen years ago with the same symptoms as before but now more severe. A third similar attack of illness occurred two years ago with all the classic symptoms described here, from which he is still suffering at the present time.

Physical Examination: Patient is well developed and well nourished for a man of his age, and weighs about 155 lb. The abdomen was quite distended and on deep palpation on the right flank a definite mass could be made out which was tender to the touch and was presumably the kidney, which, apparently running across the midline, presented a resistant body below the area of the umbilicus. Also on the left side on deep palpation, lower than normal and in the left lateral portion of the middle of the abdomen, there could be detected a resistant mass of unusual shape and tender on palpation, giving the impression of a possible ectopic fused kidney.

External Genitals: Normal. Rectal examination negative. The urine, first and second glasses, was clear and the third was slightly hazy.

Cystoscopy and Renal Functional Test: On January 18 patient was cystoscoped after meatotomy. The interior of bladder was negative. Both ureters were catheterized and specimens sent to the laboratory for culture and for urea and microscopical examination. The report of the ureteral specimen was as follows: Character bloody, urea and phenolsulphonaphthalein elimination from both sides equally good. The culture was negative.

Roentgenography and Pyelography: The x-ray report of the genitourinary tract was negative to shadows of urinary calculi, but revealed a most interesting shadow of a fused organ, as in horseshoe kidney. The right pyelogram showed a bifid type of kidney pelvis with some shagginess of calices and slight distortion of the pelvis, but apparently the pelvis was in normal position. Two weeks later patient was cystoscoped again and a left pyelogram taken, which revealed also a slight degree of hydronephrosis, but with pelvis and calices apparently normally placed. However, the diagnosis of horseshoe kidney was established and based on the flat x-ray picture which corresponds with the clinical findings. Patient has been receiving only urological treatments, routine cystoscopy with dilatation of the ureters and kidney pelvis lavage. He has improved somewhat but is still complaining of the abdominal pressure and other symptoms for which he came to the hospital, and gives the impression that not until the isthmus of the horseshoe kidney is divided by a symphysiotomy operation will he definitely be relieved of his abdominal pain and urinary symptoms.

CASE xv. L. H. male, aged sixty-seven, was admitted to the Urological Department of the New York Hospital May 4, 1929, complaining of frequency of urination day and night with intermittent hematuria for the last four years. Also occasional attacks of pain of moderate severity in the left lumbar region. He stated he had suffered with slight pain across his back for more than twenty-four years, which he attributed to rheumatism. All these symptoms have been getting worse during the last month and he entered the hospital for relief. On physical examination a slightly tender mass could be felt on the left upper quadrant. Urinalysis revealed pus 3 plus, blood 2 plus, specific gravity 1.015, acid reaction and appearance hazy with a slight trace of albumin. Wassermann test negative. On May 3 cystoscopy revealed no blood from either ureteral orifice. A No. 6 catheter passed to each kidney pelvis without difficulty. Specimens from each side and also from the bladder were sent to the laboratory for culture, and urea and microscopical examination. Phenolsulphonaphthalein appeared on the left side in five minutes, on the right in nine minutes. The urea concentration was 25 gm. per liter on the right, 18 gm.



FIG. 45. Plain roentgenogram of Case xv revealing a shadow of a renal calculus in the area of the left kidney, and in contact with the ureteral catheter.



FIG. 46. Left pyeloureterogram of same case, revealing rotation of pelvis with the lower calices turning inward toward the midline, and assuring the presence of a horseshoe kidney. Also hydronephrosis covering the previous shadow of the renal calculus.

on the left. The microscopical examination of sediment showed pus cells on the left side. Culture was negative. Plain x-ray pictures and left pyelogram were taken. The roentgenographical report revealed the presence of a shadow in the area of the left kidney, apparently

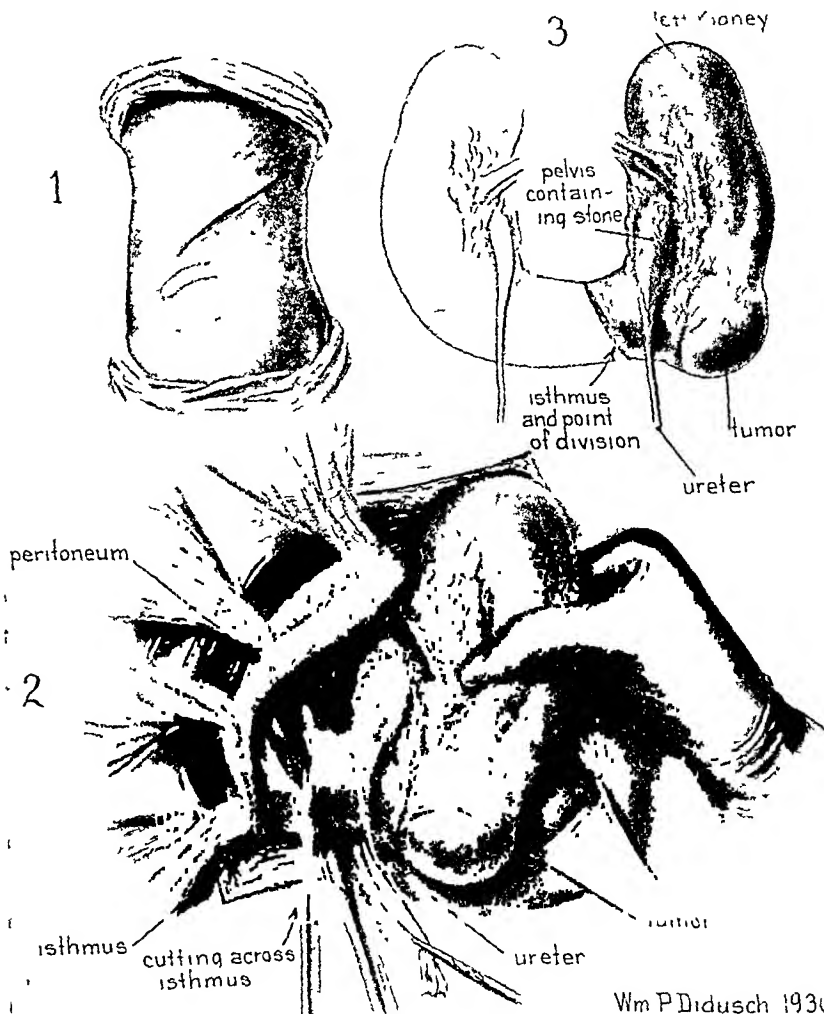


FIG. 47. Drawing of the operative technique in Case xv where heminephrectomy was performed with success. 1. Oblique lumbar incision. 2. Exposure of the left half of the horseshoe organ and the division of the isthmus. 3. Showing the horseshoe kidney and the incision carried out in the isthmus where the left half of the viscus was removed (De Vries and Lowsley's case).

a renal calculus. The left pyelogram showed a very much dilated pelvis with shagginess and evidence of chronic infection, covering the previous shadow of the renal calculus. The pelvis was unusual in shape, slightly rotated with the lower calices pointed toward the midline, thus revealing a congenital malformation in the shape of a horseshoe kidney. The patient was operated upon under paravertebral novocaine anesthesia on

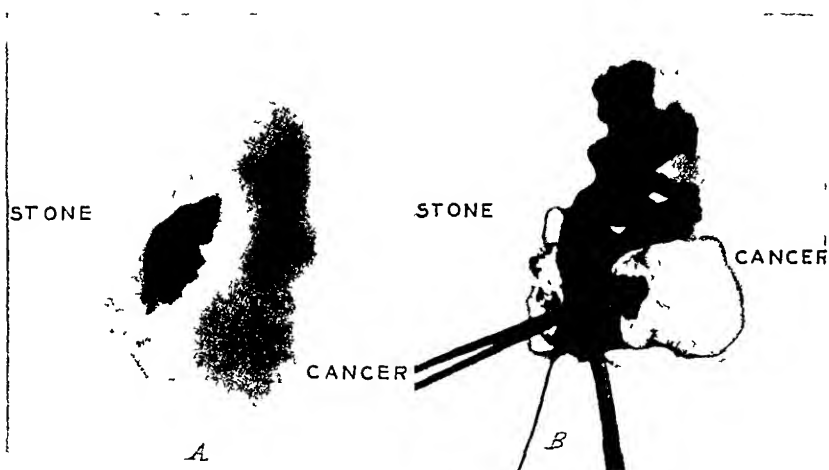


FIG. 48. Plain roentgenogram (a) and pyelogram (b) of the specimen in Case xv. Left half of horseshoe kidney removed at operation, showing the pathological lesions.

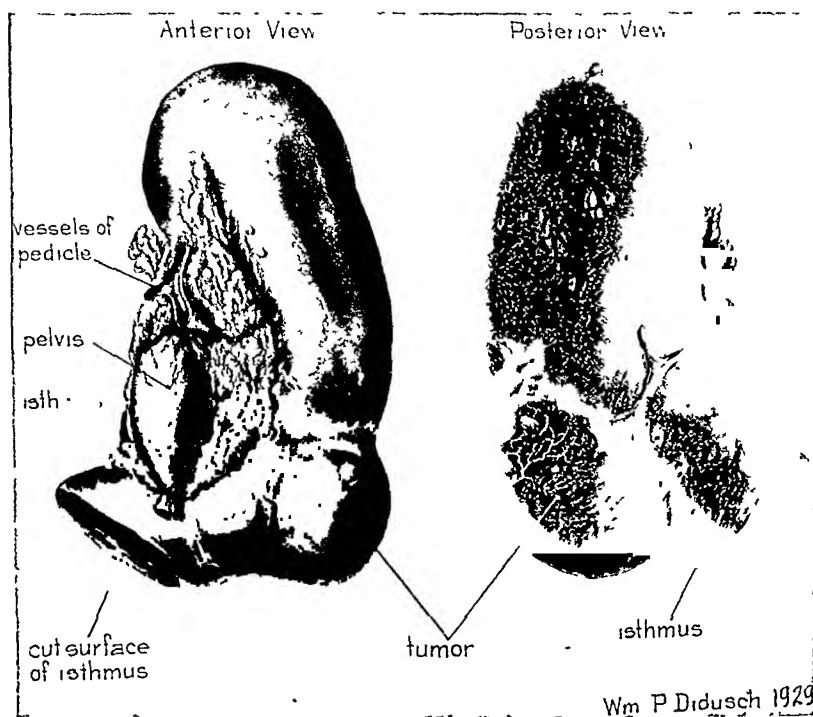


FIG. 49. Drawing of specimen removed at operation in same case, revealing the anterior and posterior surfaces of the left heminephrectomized horseshoe kidney.

May 7, 1929 and the kidney exposed in the usual manner by lumbar incision. The lower pole was found firmly adherent and connected with the kidney of the opposite side by a thick isthmus of parenchymal renal substance. It was easily made out and there was a

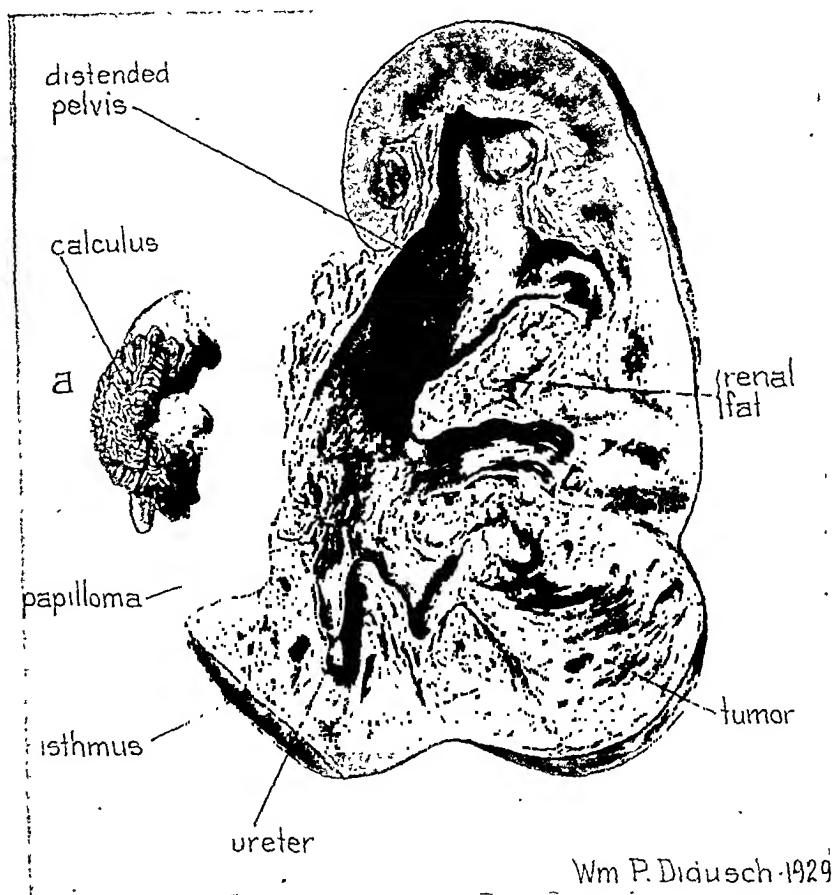


FIG. 50. Sagittal view of the left half of the heminephrectomized horseshoe kidney of Case xv, showing the striking coincidence of calculus, hydronephrosis, papillomata in the pelvis and hypernephroma in the lower pole of the same organ. Patient had an uneventful recovery.

definite indurated mass at the lower pole of the kidney. In view of these findings, heminephrectomy was carried out. The isthmus was clamped and cut across, and after the usual ligation of the ureter and pedicle, half of the left horseshoe kidney was removed. The stump of the raw isthmus was sutured and covered with fat and the edges of the wound brought together without difficulty. Two cigarette drains were placed, one in the renal fossa and the other close to the sutured portion of the isthmus of the horseshoe kidney. The wound was closed in layers in the usual manner and patient had an uneventful recovery, leaving the hospital on May 28, 1929, definitely improved and apparently cured. The pathological report of the specimen removed at operation revealed the half

of a horseshoe kidney with stone in the left kidney pelvis and a tumor at the lower pole of the same half. The histological section of this kidney tumor has been classified as carcinoma. In this unusual case therefore, we find a coincidence of three distinct pathological lesions.

CASE XVI. T. S. D., male, aged forty, history No. 288,863, admitted to the Urological Department of the New York Hospital on Sept. 25, 1929, complaining of severe pain on left lumbar region of a few hours' duration.

On physical examination the abdomen was slightly contracted with tenderness extending up into both lumbar regions which makes palpation of the kidney impossible. The patient gave a history of having had on frequent occasions a dull lumbar aching at times in the umbilical region. He had also suffered for several years with mild nocturia and frequency. Sept. 26, 1929, cystoscopy, bladder negative, both ureters catheterized, complete urological examination with functional test done. X-ray films revealed no shadow indicative of stone in urinary tract. The shadows of the kidneys were indefinitely made out. Both left and right lower poles appeared to be low in position. Left pyelogram showed a moderate degree of hydronephrosis with a peculiar inverted pelvis and excavation of the left kidney with the calices pointing inward. Right pyelogram showed distorted calices with a somewhat rotated pelvis pointing toward the midline. The impression was that of a horseshoe kidney with bilateral hydronephrosis and pyelonephritic infection. Patient was discharged improved October 3, 1929, but was advised to return to the clinic for further cystoscopical treatment with dilatation of the ureters and kidney pelvis lavage.

CASE XVII. A. Z., female, aged forty, housewife, referred to Arthritis Clinic of Hospital for Ruptured and Crippled of New York on April 1, 1927, under the care of Dr. G. C. Snyder, complaining of "chronic arthritis" of more than four years' duration. Patient is married, has 2 boys and 2 girls all living and well. She states that she has been treated by numerous doctors and has been receiving treatment in various hospitals for her arthritis condition, also that the baking and massage have made her worse and brought no relief to the intermittent pain across her back. She is inclined to be chronically constipated, for which condition she has been receiving frequent enemas and high colonic irrigations. Otherwise her general condition is good. As she complained of pain across her back and sometimes in the left lower quadrant and umbilical region, she was referred to the Urological Department of the same Hospital. Her chief complaint at that time was of slight frequency of urination and nocturia with pain in the middle of the abdomen and radiating to both lumbar regions. She also has pain across her back and in the spinal column, which sometimes interferes with her breathing, and she is easily tired on working or standing. She states she has been suffering with arthritis and chronic constipation for many years for which she has been taking cathartics, enemas and rectal douches. She has also been complaining of occasional attacks of cystitis. The urine is hazy and contains microscopic pus. On May 9, 1927, cystoscopy revealed a normal bladder. The ureters were catheterized without difficulty, and there was good renal function on both sides. Roentgenographical examination revealed no shadow of stone anywhere in the urinary tract, but showed a left kidney shadow of large size and very low in position, also a few shadows in the bony pelvis, apparently phleboliths. The left pyelogram revealed rotation of the kidney pelvis with a slight degree of hydronephrosis, the lower pole extending beyond the midline and giving the impression of horseshoe kidney with infection on the left pelvis. Later, on June 24, 1927, a pyelogram of the right side revealed rotated kidney, with an unusual pelvis and some excavation of the middle calices which pointed inward. The ureterograms were negative, except that the course of the ureters

alongside of the spinal column gave the impression of a "flower vase" which appears to be peculiar to the ureters in cases of horseshoe kidney. The renal function was not particularly diminished on either side, but in view of the presence of pus cells and red cells in the catheter specimen, the patient was advised to have routine cystoscopic treatment with dilatation of the ureters and kidney pelvis lavage in order to relieve infection and secure better drainage, which was accordingly carried out on several occasions. The result was gratifying, although the patient still complains from time to time of her horseshoe kidney symptoms but has not been able to return to the clinic for further treatments, for extraneous reasons.

CASE XVIII. W. S. male, Italian, aged thirty-eight, history No. 296,876, came to the admitting room of the Urological Department of the New York Hospital on Jan. 6, 1931, complaining of pain in the bladder region and in the epigastrium, radiating across the back and particularly to the right lumbar region. Family history irrelevant. Patient has been suffering for several years with dysuria, frequency and some bladder symptoms; also with gastric trouble and chronic constipation for several years. He denies venereal disease. On physical examination the abdomen was rigid and contracted but on deep palpation the kidneys were easily palpable and enlarged. There was also tenderness in the suprapubic region. The urine had been hazy for some time and apparently contained pus. Blood pressure was normal and Wassermann test negative. Cystoscopy January 7, 1931, revealed a much congested mucosa and bulbous edema. Around the ureteral orifices and floor of the trigone, lying at the fundus of the bladder, was a stone about the size of the terminal phalanx of the fifth finger. Both ureters were catheterized without difficulty and revealed diminished function in regard to urea excretion and phenol-sulphonephthalein elimination. Microscopical examination of the sediment showed pus and blood cells coming from both sides. The roentgen examination disclosed the presence of stone in the bladder, and there was also a shadow about the size of a large olive over the transverse process of the third lumbar vertebra on the left side, which moved considerably in the various pictures and was apparently a calcified lymph-gland. The shadow of the kidney was larger than usual and the bilateral pyelogram revealed rotation of the pelves with the lower calices pointing inward toward the midline, thus indicating the presence of a horseshoe kidney. In this case the stone was crushed and removed from the bladder with the Lowsley rongeur. Patient has been receiving urological treatment with dilatation of ureters and kidney pelvis irrigations. Hence no surgical intervention has been considered.

CASE XIX. N. S. male, aged thirty-six, history No. 177,402, came to the Urological Clinic of the New York Hospital on July 17, 1930, complaining chiefly of burning on urination, frequency, pain in the upper abdomen, particularly in the umbilical region. The urine at times has been cloudy and he has been receiving medical treatment by a private doctor on various occasions, but without definite relief. He has also been suffering with gastrointestinal disorders and chronic constipation for many years. About twelve years ago he had an attack of Neisser infection, since which time he has not had any urethral discharge. However, the urine has been cloudy and the symptoms have been aggravated in the last two years. Patient had various kinds of medical examinations and treatments by various doctors and had been cystoscoped elsewhere. He stated that guinea-pig examination of the urine had been negative, but a culture of the urine had disclosed the presence of *Bacillus coli communis*. However, according to his statement, no one knew what was the cause of his trouble. On physical examination patient was well nourished and on deep palpation of the abdomen the kidneys appeared to be enlarged and tender. He was cystoscoped July 20, 1930, and the bladder mucosa was found to be

red and congested throughout but no evidence of pathology found in the urinary bladder. The ureters were catheterized without difficulty and the specimen from both sides was cloudy, with microscopic pyuria and hematuria. The function was slightly diminished, but urea excretion was good and phenolsulphonephthalein appeared in five minutes on each side. The roentgen examination revealed no shadow indicative of stone in the urinary tract, and the kidney shadows were indefinitely made out, but were low in position. The bilateral pyelogram revealed dilatation of both kidney pelves with slight degree of hydronephrosis. Both pelves were rotated and the lower calices turned inward toward the vertebral column, indicating the presence of a horseshoe kidney. Patient has been coming to the clinic for cystoscopic treatments with dilatations of ureters and kidney pelvis lavage. While he has improved his symptoms have not cleared up and he is still complaining of the horseshoe kidney syndrome.

Cases of Horseshoe Kidney Diagnosed at Operation

CASE XX. M. F., male, aged fifty-six, history No. 280,898, admitted into the medical ward of the New York Hospital July 21, 1928, complaining of indefinite pain in the umbilical region and lower abdomen with loss of weight, progressive weakness and a history of chronic constipation.

On physical examination the abdomen was tender and an indefinite tumor mass about the right lower quadrant was made out, for which an exploratory laparotomy was recommended. At operation a retroperitoneal fused kidney of the horseshoe type was found, together with chronic appendicitis. Appendectomy was done and the diagnosis after operation was that of a horseshoe kidney plus chronic appendix. The patient made an uneventful recovery and left hospital "improved."

CASE XXI. C. M., female, aged thirty-two, history No. 39,713, admitted to the medical service of the New York Hospital May 8, 1910 with symptoms of pain in epigastrium and a history of stomach trouble after eating. The urine was apparently clear. On physical examination there was slight tenderness in the abdomen, particularly at McBurney's point. In the course of an operation for chronic appendicitis a fused kidney of the horseshoe type was discovered. The patient had an eventful recovery from the appendectomy and left the hospital apparently improved.

Cases of Horseshoe Kidney Found at Post Mortem

CASE XXII. P. W., male, aged sixty-six, admitted to the Urological Department of the New York Hospital April 3, 1923, complaining of inability to urinate and pain over bladder and umbilical region. He had been tapped twice elsewhere with temporary relief but came to the hospital suffering with complete retention after having used a ureteral catheter for more than five weeks. On examination, a scar for perineal operation was noticed. There were moderate hemorrhoids and the prostate was enlarged to about twice the usual size and of leathery consistency. On account of the irritation and inability to tolerate an indwelling catheter a suprapubic cystotomy for drainage was done April 6 under local anesthesia. Patient became very sick and his renal function alarming. On May 7 the blood urea nitrogen was 34.27 and on May 8 he died in a uremic coma. The clinical diagnosis was uremia, renal failure and chronic endocarditis, complicated by enlargement of the prostate.

Autopsy No. 5732. Anatomical Diagnosis: Acute cystitis, chronic endocarditis, hypertrophy of prostate, chronic myocarditis, right hydrocele and infected horseshoe kidney. The direct cause of death, while undetermined, was apparently chronic endo-

carditis due probably to the horseshoe kidney disease. Pathological findings and type of lesion: The kidney is of the horseshoe type united by an isthmus which runs across the lower poles and in front of the great vessels. The organ weighs 280 gm. The ureters and

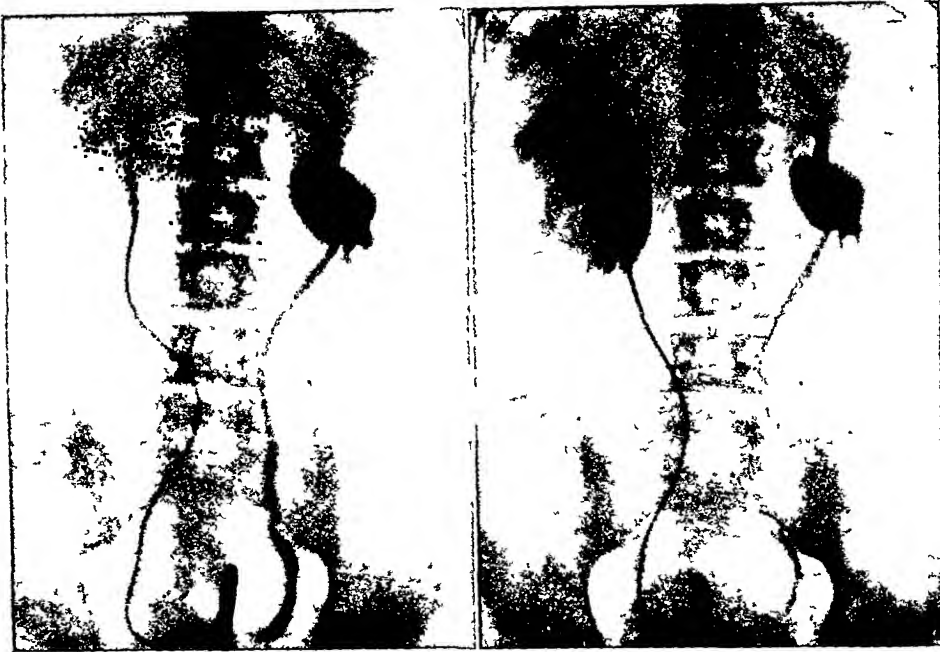


FIG. 51.

FIG. 52.

FIG. 51. Left pyeloureterogram revealing marked rotation and inversion of the pelvis with the upper and lower calices pointing inward, at first giving the erroneous impression of horseshoe kidney. However, the outline of the lower pole is plainly visible and in addition the delineation of the psoas muscle can also be seen.

FIG. 52. Bilateral pyelogram of the same case, to illustrate the necessity of making bilateral pyelograms in order to rule out anomalies of rotation which are not horseshoe kidney. The pyelogram of the opposite side shows no anomaly in shape or position, and the clear outline of the normally placed pelvis and lower pole of the organ excludes the diagnosis of horseshoe kidney.

pelvis lie anterior to the kidney parenchyma and are divided in such a manner that there is practically no renal pelvis. This division of the ureters corresponds to the somewhat indefinite division of the fused kidney into four organs, which are suggestively outlined by lobulations. The vessels enter the horseshoe kidney at a number of definite points along the superior border of the fused organ; the position of the abnormal organ is rather low in the lumboiliac pelvis, so that the upper poles are not in close contact with the adrenals. Sections reveal preservation of normal line markings. However, microscopical examination of the kidney tissue shows that the tubular epithelium and also the glomeruli are undergoing fairly well marked degeneration. There appears to be slight increase in the interstitial connective tissue and further degeneration and changes of chronic nephritis.

CASE XXIII. A. M. W., female, aged fifty-two, history No. 289,909, admitted into the medical ward of the New York Hospital Nov. 23, 1929. The clinical diagnosis was per-

forated gastric ulcer, gelatinous carcinoma of stomach, secondary anemia. Patient died Jan. 29, 1930.

Autopsy No. 6909. Anatomical Diagnosis: Carcinoma of the stomach, gelatinous ulceration of carcinoma; hourglass constriction of stomach. Blood in intestinal canal. Generalized edema. Moderate dilatation of heart. Hemorrhage through gastrointestinal tract. Infected horseshoe kidney. Direct cause of death: Carcinoma of stomach. (Horseshoe kidney?)

Pathological Findings and Type of Lesions: Kidneys are fused together, making a horseshoe kidney by the union of an isthmus across the vertebral column which unites both lower poles. The organ weighs 225 gm. The structure is crescent shaped. Capsules strip rather readily and the organ is rather light in color but has a smooth surface. On incision the markings are fairly regular; each half of the organ is drained by a single ureter which is attached to the anterior pelvis. The isthmus of the fused organ is made of kidney parenchyma. Microscopical findings show the tubules to be rather dilated and the glomeruli undergoing degenerative changes as in the characteristic lesions of nephritis.

CASE XXIV. P. M., male, aged thirty-five, history No. 288,262, admitted into the medical division of the New York Hospital Aug. 21, 1929.

Clinical Diagnosis: Retroperitoneal lymphosarcoma.

Date of death: Sept. 21, 1929.

Autopsy No. 6834. Anatomical Diagnosis: Retroperitoneal lymphosarcoma with extension to stomach, spleen and mediastinum, and with ulceration into the stomach. Generalized arteriosclerosis. Dilatation of heart. Horseshoe kidney with double pelves and double ureters on left side. Direct cause of death: Retroperitoneal lymphosarcoma with many metastases and marked emaciation. (Horseshoe kidney?)

Pathological Findings and Type of Lesions: Kidneys are connected across the midline by the lower poles and in front of the great vessels, giving the horseshoe arrangement. The left kidney has a double pelvis and double ureter, which opens into the left side of the apparently normal bladder. The ureters and pelves are situated anterior to the kidney substance; otherwise the kidney tissue and ureters are not unusual, except for a moderate dilatation of the ureters and calices. The kidney parenchyma appears normal. Microscopically one section of kidney shows granular degeneration of the parenchyma and edema of the glomeruli. In another section there is a circumscribed mass of lymphocytes and polymorphonuclears. The glomeruli in this section show advanced hyaline degeneration and other changes that suggest the presence of chronic interstitial nephritis.

CASE XXV. A. M., female, aged fifty, hospital No. 288,691, admitted to the New York Hospital Sept. 16, 1929.

Clinical Diagnosis: Aneurysm of arch of aorta. Lues. Carcinoma of rectum (?). Diabetes mellitus, mild.

Date of Death: Sept. 30, 1929.

Autopsy No. 6838. Anatomical Diagnosis: Aneurysm of arch of aorta. Luetic aortitis. Carcinoma of rectum. Adherent pericarditis. Horseshoe kidney fused across the midline by the upper poles.

Direct Cause of Death: Undetermined (syphilis, toxemia, cancer, horseshoe kidney disease).

Pathological Findings and Type of Lesion: Kidneys are fused by the upper poles in a most rare and unusual type of horseshoe kidney, the right being lower than the left but otherwise fairly normal in position. The entire specimen weighs about 350 gm. The isthmus that unites these upper poles is of definite renal parenchymal tissue and the concavity opens downward. The pelves are small, the left one containing two almost

separate portions. The pelves and ureters appear to lie anteriorly to the renal vessels and to the kidney parenchyma. The kidney substance seems rather pale. The capsules strip with some difficulty and leave scars behind.

Microscopical Findings: Renal degenerative changes of tubules and glomeruli. Glomeruli are edematous in appearance while others are hyalinized as in lesions of chronic nephritis.

In Conclusion: This unusual type of horseshoe kidney is worthy of recording because, according to Papin and other writers, there have been only 13 cases of this type described in the literature.

XI. TREATMENT

In the series of horseshoe kidneys which form the basis of this presentation the treatment has necessarily been most varied, partly because of the different types of cases and partly because of the difficulty in following up out-patients. Furthermore, in some instances in which no gross concomitant pathology was present the entity of horseshoe kidney disease *per se* has not been recognized and therefore nothing more than the usual urinary antiseptics and kidney pelvis lavage has been recommended. However, in studying the management of this condition together with the etiological factors and the rôle of the anomaly as predisposing to disease and to further pathology, one must conclude that on general principles, in all cases of renal fusion accompanied by the horseshoe kidney syndrome, with or without associated pathology, the fused organ must be considered in reality as a potential surgical kidney. This study has also revealed that in the great majority of cases no relief of symptoms can be definitely obtained until the isthmus of the horseshoe renal organ has been divided by the conservative surgical procedure of a symphysiotomy operation.

It is obvious, moreover, as I have already pointed out in the chapters on etiology and anatomic structure, that the high ventral implantation of the ureters does not permit the normal drainage of the pelvis, and also that the relative fixation and tension of the organ across the midline, plus its weight and pressure upon the great abdominal vessels of the blood, nerve and lymphatic circulation, interfere with the dynamic physiologic contractions of the excretory apparatus, thus producing chronic stagnation of both the urinary and gastrointestinal tracts. Hence the great majority of patients suffering from horseshoe kidney disease do not appear to obtain permanent cure under the ordinary medical and urological treat-

ment. It appears, therefore, that in the solution of this problem the only possible avenue to permanent relief or cure must lie in a surgical approach such as is offered by division of the isthmus of the fused organ and the liberation of the ureter to provide free drainage and restoration of normal function.

As an illustration of this fact we see that in this series of 25 cases only 2 appear to have been cured, and that these are precisely the two in which heminephrectomy was carried out for a stone complicating hydropyonephrosis in one half of or on one side of the fused organ. The rest of these cases are classified as follows: Improved but still with symptoms, 10 patients; unimproved, 7 patients; died, 2 patients; (one from pneumonia complicating horseshoe kidney disease and the other from acute uremia due to the horseshoe kidney). Four other patients died from different causes, but horseshoe kidney was found in all at post mortem.

It seems, therefore, that in order to solve this clinical problem before any concomitant lesion arises and to bring permanent relief of symptoms that have already appeared, three modes of management of this condition must be considered: the medical, the urological and the surgical. These three modes may be summarized and discussed in two essential groups:

1. Acute cases of horseshoe kidney with or without associated pathology.

2. Chronic cases of horseshoe kidney disease with clinical symptoms.

1. In the group of cases of horseshoe kidney disease with acute clinical manifestations, after correct preoperative diagnosis the paramount consideration is the maintenance of urinary drainage in order to relieve infection, autointoxication and back pressure. In the majority of instances the urinary stasis produced by lack of proper drainage is the true cause of the infection and of the development of hydronephrosis, pyohydronephrosis, acute pyelitis and pyelonephritis, nephritis, perinephritis and perinephro-ureteritis which, when clinically acute, are manifested by high temperature, chills, fever, sepsis, gastrointestinal disorders, nausea, vomiting, severe pain in the epigastrium, uremic symptoms and pyuria, dysuria or hematuria, etc. When a clinical picture of this type reveals the gravity of the condition, expectant medical and urological treatment

is indicated, consisting of the administration of urinary antiseptics internally, and of forced fluid either by mouth or by rectum with enemas and high colonic irrigations, cathartics and intravenous infusion of normal saline solution, accompanied by rest in bed, heat and other common proper measures. At the same time the use of indwelling ureteral catheters is essential to secure drainage and to relieve infection. Several of the cases here reported have been treated in this way with satisfactory results, as I have described elsewhere with the report of my first case.¹

Later on, when the patient is out of bed, he should be put on a suitable non-protein diet with appropriate medication, and should receive cystoscopic treatments at ten-day or two-week intervals in order to dilate the ureters and irrigate the kidney pelvis, using a mild antiseptic solution, such as acriflavine 1:1000, revonol dextrose 1:2000 or silver nitrate 1:1000, thus assuring the maintenance of perfect drainage and preventing the development of infection or formation of stone or further pathology. The treatment, in short, is that of an ordinary case of pyelitis or pyelonephritis.

2. While patients suffering with acute horseshoe kidney may improve under this treatment, it has been observed that in the great majority of cases that have been traced over a long period of time, as in this series, they are bound to relapse and to have frequent attacks of their trouble. The horseshoe syndrome persists with its abdominal pain, its urinary symptoms, its gastrointestinal disorders, and its habitual or usual chronic constipation; the urine is hazy or cloudy from time to time and contains pus and blood cells and albumin, a certain degree of nephritis is present and the individual almost invariably becomes incapacitated from horseshoe kidney disease. In this group of chronic cases, therefore, after palliative treatment has been exhausted, the symphysiotomy operation, to divide and separate the isthmus of the fused renal mass, should constitute the most correct and final indication for assuring a curative prognosis.

Martinow, on March 9, 1909, was the first to divide the isthmus in order to separate the two fused kidneys. But it appears that Rovsing on June 17, 1910, was the first to describe in full the

¹ Gutierrez, R. The value of indwelling ureteral catheters in urinary surgery. *Surg. Gynec. Obst.*, 50: 441-454, 1930.

technique of the new operation that bears his name, reporting a successful case and pointing out the advantages of the method even in the normal horseshoe kidney. He recommended the transperitoneal route of approach by the midline incision of laparotomy, but while the method was practiced by Kroisz, Brougersma, Van Houtum, Kidd and others it has never gained popularity for the reason that practically all these kidneys are infected; hence, the great damage inflicted in the contamination of peritoneum is obvious.

It was Papin who, on October 22, 1922, introduced a modified technique using the Pian transverse lumbo-anterior incision for an extraperitoneal approach to separate the isthmus of the fused organ with satisfactory results. According to this author and the tabulated study of cases collected from the literature by Eisendrath, Phifer and Culver as well as other authors mentioned previously, it appears that all those patients who submitted to the division of the isthmus, or renal symphysiotomy operation, have had complete relief of pain and symptoms. In dividing the isthmus, as Papin has pointed out, it is advisable to do a nephropexy or suspension of half of the organ on the side at which the operation has been performed, since this allows the kidney to swing back into the lumbar fossa where it normally belongs and at the same time permits the other half on the opposite side to move away from its unique position upon the solar plexus and the great abdominal vessels, thus ultimately serving to bring about a permanent cure. In addition care should be taken of the aberrant renal and pyelic vessels, as well as of the adhesive bands of tissue which interfere with free ureteral drainage. The kidney should be placed in such a position that the pelvis and inferior calices will secure a perfect drainage. The ureter should be liberated from the isthmus and from its renal surface and peritoneal attachments in order to restore the physiological mechanism of its function. With a good preoperative diagnosis and a precise technique, in order to control any oozing or bleeding from the divided renal isthmus, these operations can be carried out with safety and without great difficulty. They result in permanent cure, as in the two cases of heminephrectomy here reported in which the technique was more or less that of an ordinary nephrectomy or partial heminephrectomy.

Other operations may be required in the surgical management of horseshoe kidney, particularly when the presence of associated

pathology demands them and obviously when the other half of the organ has enough function to maintain life. In this series of cases, two patients were heminephrectomized successfully for hydropyonephrosis complicating stone in one-half of the organ, with curative results. Two other patients were operated upon for the removal of renal stone by an anterior pyelotomy. One cystostomy was done and one litholapaxy, and in 3 cases stone was removed from the ureters and bladder by cystoscopic and ureteral manipulations. Although many of these patients have improved considerably under medical and urological treatment, some of them who still have clinical symptoms and in whom a surgical procedure was planned have not been traced or have not come back to the clinic, while others have refused the operation. The writer, however, is firmly convinced of the beneficial results of the symphysiotomy procedure and believes that it is properly indicated in this type of cases of symmetric horseshoe renal fusion. He expects in the near future to be able to report an improved technique and the results obtained from the same.

XII. SUMMARY

In summing up the clinical management of horseshoe kidney it is obvious that accuracy in establishing a correct diagnosis and the proper indications for medical, urological and surgical treatment are the paramount considerations for the assurance of a sound prognosis.

Horseshoe kidney disease as a new clinical entity can be easily recognized both clinically and radio-uographically, and whenever the horseshoe syndrome of nephralgia and other clinical manifestations is suggestively present, the urographic examination will confirm and verify the final diagnosis.

Bilateral instrumental pyelograms whenever possible (taken at different sittings if necessary) or intravenous uroselectan pyelograms are absolutely necessary, not only for the verification of the diagnosis but also in order to exclude the possibilities of other abnormalities, since the lack of, or the incomplete, rotation and inward inversion of one pelvis seen in a unilateral pyelogram, does not always mean the presence of horseshoe kidney. We must also exclude the embryonic type of renal pelvis and the unusually placed

pelvis due to an ectopic kidney or dystopic asymmetric renal fusion, or to a certain degree of nephroptosis, or to torsion or renal misplacements resulting from trauma or intraperitoneal or extra-peritoneal neoplasma. To this end the routine procedure of measuring the basal angle in the horseshoe triangle as here proposed by the author will serve as a means of eliminating error and clarifying the final diagnosis.

Nevertheless, it is essential that the diagnosis shall correspond with the clinical condition of the patient, and to be complete it should be based in the following roentgenographic and urographic data: (1) The visualization of the outline and position of the kidneys; (2) the possible delineation of the isthmus; (3) renal shadows of calculi close to the vertebral column or overlapping it; (4) in a bilateral pyelogram, the abnormal rotation of the pelves; (5) the lower calices pointing inward; (6) the "flower vase" position of the ureters; (7) the "bottle neck" shape at the ureteropelvic junction; and (8) the "pathognomonic pyelographic horseshoe triangle" with its minimum basal angle hovering around 20° . A consideration of all these points in the diagnosis will definitely reveal the presence of the clinical entity of horseshoe kidney disease.

In looking over this series of cases, one cannot fail to be struck by the fact, that, of the group of 19 patients diagnosed preoperatively, practically every one came in with an erroneous diagnosis, and 12 of this group had already been operated upon elsewhere for various abdominal conditions, before our diagnosis of horseshoe kidney was made, thus bringing out the paramount importance and necessity of a correct preoperative diagnosis.

The treatment of this condition in acute cases should be medical and urological, but later on, when the patient has recuperated from the acute symptoms and complete invalidism, and before any further pathology develops, it should always be surgical, establishing the division and separation of the isthmus of the fused organ by renal symphysiotomy. This operative procedure should be followed at the same time by a nephropexy or suspension of one half of the organ on the side where the operation has been performed. Care should also be taken to free the ureter and pelvis from bands of adhesions and aberrant blood vessels, in order to restore ureteric and pelvic dynamic physiological function and to secure a better drainage.

All in all, the results obtained in the clinical management of this series of cases have been most gratifying, particularly when urological treatment has been systematically carried out in the form of dilatation of the ureters and kidney pelvis lavage and in the acute cases when the indwelling ureteral catheter has been used, thus saving patients from uremia and death.

Of the 19 cases diagnosed preoperatively, 15 (79 per cent) were suffering with pyelitis and pyelonephritis infection due mainly to urinary stasis and lack of proper drainage, which are obviously the chief etiological factors in horseshoe kidney disease and represent the beginning of its most common complication.

XIII. CONCLUSIONS

1. Horseshoe kidney disease is physiologically, anatomically, pathologically and surgically of sufficient frequency to warrant its medical recognition as a new clinical entity of paramount importance.

2. The disease is produced mainly by the unique position of the anomalous organ in the middle of the abdomen and in the retro-peritoneal space, lying where it not only makes pressure upon the aorta, vena cava, solar plexus and other anatomic structures, but also, where by its incarcerated position, it is prevented from performing its own normal physiologic function.

It is clinically characterized by the presence of the horseshoe kidney syndrome, namely, (a) nephralgia or pain in the middle of the abdomen referred to the epigastrium or umbilical region; (b) gastrointestinal disorders with a long history of marked chronic constipation, and (c) long-standing intermittent attacks of urinary disturbances (see Table IV of the text).

3. Every individual who is born with this type of renal fusion is potentially suffering from a certain degree of horseshoe kidney disease (chronic, acute or subacute).

4. Two types of horseshoe kidney must be considered, the symmetric and the asymmetric. In the symmetric type, the fusion of the two organs is made by the union of the lower or the upper poles by an isthmus of renal parenchyma, with a concavity facing upward or downward, and with the connecting isthmus lying in the midline across the vertebral column, in front of the great abdominal

vessels and adherent to the parietal layer of the peritoneum. This anomaly of renal fusion constitutes the typical anatomic structure which is characteristic of the true type of horseshoe kidney disease. In the asymmetric type the two kidneys are united in various other abnormal forms and occupy an ectopic position. This very unusual renal anomaly, which as a rule is placed low down in the bony pelvis or at one side of the spinal column, is in reality not of the true horseshoe type, and will be discussed later in another paper. Of the first type of symmetric renal fusion or renal symphysis, 25 cases are here reported.

5. The etiological factors in the fusion of the two kidneys, while undetermined, appear to date from the first weeks of embryonic life when the two kidney blastemata are imbedded and placed together topographically within the preaortic mesodermal membrane of the mesonephros, whereupon, probably for lack of migration and rotation, the two organs unite to constitute the semicircular horseshoe renal mass before they have a chance to ascend into the normal position in the lumbar fossae of the adult.

6. All of the cases in this series were found to have various degrees of pathology. Twelve of the patients had been operated upon elsewhere for various abdominal conditions under erroneous diagnoses, without obtaining symptomatic relief and before our diagnosis of horseshoe kidney was made. Two deaths occurred in this series, one from uremia and one from a pneumonia complication, but both probably as the result of horseshoe kidney disease of long standing. Four other deaths have been reported, of patients in whom horseshoe kidney was found at autopsy, and in whom it can be fairly assumed that the kidney anomaly played an important part in the concomitant pathology and the causation of death. In only 1 case, found at necropsy, were the two halves of the organ united by the upper pole, which constitutes a very rare instance.

7. Of the 25 cases here reported, 19 were diagnosed preoperatively by urologic and radio-urographic examination, 2 were discovered at operation and 4 at autopsy. Of the 19 cases that received urologic and urographic examination, the diagnosis was correctly made in all, leading to the conclusion that when the patients are submitted to a complete and accurate examination the diagnosis can be established in 100 per cent of the cases.

8. Most of the pathology found is due to the high implantation of the ureters and to the ventral position and inward rotation of the pelves with the lower calices extending transversely into the renal isthmus, a condition which is obviously responsible for the lack of normal drainage and which leads ultimately to urinary stasis, thereby causing continuous irritation and infection, with histopathological evidence of chronic pyelitis and pyelonephritis, nephritis and perinephritis and in some instances the formation of hydro-nephrosis, pyonephrosis or even fatal uremia (see Tables I, II and III).

9. The weight, pressure and relative fixation of the incarcerated organ, plus the continuous tension caused by the intra-abdominal pressure, interfere with the dynamic physiologic function of the entire excretory apparatus and become responsible for the chronicity or exacerbation of all the abdominal symptoms and for the chronic stagnation of the intestinal as well as of the urinary tract.

10. The diagnosis of this condition must be based in the first place on the suggestive signs and symptoms and should then be confirmed by both roentgenographic and urographic examination, with the main dependence placed on the bilateral pyelogram, obtained either by instrumental pyelography or by intravenous injection of uroselectan.

11. Other important points in the diagnosis are the comparative estimation of renal function and the determination of concomitant or associated pathological lesions, in order to establish the appropriate operative treatment.

12. The graphic points for establishing a correct diagnosis of horseshoe kidney are as follows: (1) The visualization and perfect outline of the position of the kidneys; (2) the possible delineation of the isthmus by the roentgen ray; (3) renal shadows of calculi close to the vertebral column or overlapping it; (4) in a bilateral pyelogram, the abnormal rotation of the pelves; (5) the lower calices pointing inward and toward the midline; (6) the "flower vase" position of the ureters; (7) the "bottle neck" shape at the ureteropelvic junction, as if the ureters were leaving the pelves from behind; (8) the "pathognomonic pyelographic horseshoe triangle," with its minimum basal angle of approximately 20° which, taken in combination with all these other points, will reveal the diagnosis of the clinical entity of horseshoe kidney disease (see Fig. 39).

13. The treatment of this condition must be considered from three different standpoints, namely (a) medical, (b) urological and (c) surgical.

(a) In the medical treatment when acute symptoms are present, rest in bed, forced fluid, urinary antiseptics, cathartics, high colonic irrigations and intravenous infusion of normal saline solutions are indicated.

(b) The urological treatment consists mainly in securing drainage and in relief of infection by cystoscopic treatments, kidney pelvis lavage and the method of the indwelling ureteral catheters.

(c) It appears that the ideal treatment for this condition, as soon as the patient is relieved from the acute symptoms, is surgical intervention. Two types of cases must be considered: (1) Cases in which some concomitant associated pathology is present, and in which some type of surgical intervention may be required as in any other pathological lesions of the kidneys. Obviously one-half of the horseshoe organ must have enough function to maintain life, particularly when heminephrectomy is the operation to be carried out. (2) Cases in which no visualized pathology is present, but still the horseshoe syndrome is clinically evident. Here renal symphysiotomy for the division of the isthmus of the fused kidney should be the operative procedure of choice, followed by routine nephropexy, nephrolysis and ureterolysis.

14. There can be no doubt that those unfortunate individuals who have been born with horseshoe renal deformities have the same claim on the corrective possibilities offered by modern surgical procedure as those suffering with any other congenital surgical malformation of the human body under the dominion of the surgeon's knife.

In view of the fact that horseshoe kidney is universally recognized as a predisposing cause of disease, giving rise to clinical symptoms, pain and suffering, and as a rule to concomitant pathology, it appears that the solution of the clinical problem of horseshoe kidney disease must be found in the extraperitoneal operation of renal symphysiotomy or symphysiectomy, whenever possible. This operation is a conservative and preventive procedure that finds its justification in the assurance it offers of a good prognosis, finally relieving symptoms and achieving permanent cure.

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(The End)

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EDITORIALS

THE PASSING OF A PIONEER IN RADIOLOGY, GUIDO HOLZKNECHT

THE medical world as a whole and the radiological section in particular join in mourning the loss of Guido Holzknecht, of Vienna, whose untimely death was recorded in the newspapers of early November. Early roentgen injuries by their insidious and persistent influence finally wore out the resistance of this pioneer worker who succumbed only after numerous operations, including the amputation of both arms.

The work of Holzknecht has represented the acme of roentgenological development at all times, both in diagnosis and in therapy. Beginning in 1899 with a paper on a new radiological symptom of bronchial stenosis, the literature of roentgenology is

rich in the product of this wonderful man's tireless industry, more than one hundred and twenty articles having appeared from his pen during his first ten years in addition to three books by himself and two others in association with co-workers. As early as 1901 there appeared a book on the radiological diagnosis of diseases of the chest. In 1903 he published a monograph on radiology as a specialty in medical practice. In 1908 appeared the widely read text on intra-ventricular and extra-ventricular tumors, and almost simultaneously the text on the roentgen diagnosis of the stomach. Interspersed were articles exhibiting the keenest and most ingenious efforts at solution of the problem of applying roent-

genological methods to the diagnosis and treatment of a long list of maladies from acromegaly and alopecia areata to foreign bodies. As a pioneer this versatile man attacked every problem with an energy which could not be rebuffed by any difficulty.

Because of the financial stringency attending much of his early work, Holz-knecht spent an enormous amount of time at fluoroscopy, especially of the heart and great vessels, and the esophagus, stomach and intestines; and no doubt here was the cause of his martyrdom, for the injuries caused to his hands in the early work, aggravated in spite of what were considered adequate protective measures in all the later years by his continuation in fluoroscopic radiology brought about his final defeat in the painful but stubborn battle against roentgen cancer.

It would be a pity were we not to pause for careful consideration of the dangers of fluoroscopy. In this age of wide dissemination of x-ray equipment with the yearly addition of hundreds to the rapidly growing ranks of students of radiological diagnosis, there has arisen much misconception as to the place of fluoroscopy.

True, one can learn much by screen studies; here is not the place to elaborate on this point. But it is not a question of how much can be learned from fluoroscopic observation, rather what is the maximum degree to which screen studies can be dispensed with by substitution of radiographic studies. The screen is indispensable; we must have its benefits; but a little planning will permit its avoidance much of the time with no loss of diagnostic accuracy.

For example, in the stomach, with a satisfactory set of serial films one is usually able to be assured of the normal findings or the presence of an organic lesion, and the screen study may often be dispensed with on the basis of the film

study, if the films are prepared and studied first. Screen observation is a necessity in esophageal lesions and in some intestinal studies, especially in the sigmoid and cecum. In chest cases, patients are often referred for "screen and film study" when a more reasonable request would be for a "film study and screening if indicated." It is relatively infrequent that the posteroanterior stereo and the lateral films of the thorax do not suffice without screen study. As a precaution to avoid recalling occasional cases, the patient should not be allowed to leave the examining office until the roentgenologist sees the wet films and decides whether additional screen observation is needed.

From the economical viewpoint of consumption of x-ray materials, it is true that fluoroscopy is much cheaper than film studies and in this day of earnest effort to reduce the cost of medical service in the interests of those in modest financial circumstances it may superficially appear to be the desirable method of x-ray study; but the keenest eye will never begin to see in a brief study of the relatively obscure field of the most brilliantly lighted screen the greater wealth of detail shown on the permanent film record which is susceptible of repeated and prolonged study; and the economical advantage should not weigh against the apparently unavoidable insidious damage suffered to some degree by every radiologist who does fluoroscopy with the probability of the later development of chronic skin lesions on the hands, often not appearing for eight or ten years, entailing countless hours of suffering, maiming operations, to say nothing of other vital damages and in many instances final martyrdom.

Holz-knecht, we cherish your memory as an indefatigable investigator, patient and able teacher, and respected friend.

JAMES T. CASE.



PHILIP SYNG PHYSICK

[[1768-1837]]



AMERICAN PHYSICIANS

PHILIP SYNG PHYSICK

“THE Father of American Surgery,” Philip Syng Physick, was born in Philadelphia on the 7th of July, 1768.

His father, an Englishman, held office in the Colonial government as Keeper of its Great Seal, and after the Revolution he became agent of the Penn family, which brought him great riches.

As the Physicks lived in the country, seven miles out of Philadelphia, Philip was introduced as a boarder in the family of Mr. John Todd, father-in-law of the lady who, as Widow Todd, became the wife of James Madison, afterwards President of the United States. Philip was placed under the care of the historian, Robert Proud. From the academy he was transferred to the classical department of the University of Pennsylvania, where in 1785 he took his A.B. degree.

After a month's rest Physick entered the office of Dr. Adam Kuhn, then Professor of Materia Medica and Botany in the Philadelphia College of Medicine. He remained with Dr. Kuhn three and a half years. He did not take his degree but went abroad (1789) and studied under John Hunter. He became a member of Hunter's family. He was selected as house-surgeon to St. George's Hospital for one year. Physick remained under Mr. Hunter's care for two years and four

months. Hunter invited Physick to take up his residence with him and to share his professional burdens, what most people of that time would have considered an enticing opportunity. However, Physick went to Edinburgh, after receiving his license from the Royal College of Surgeons (1791), and received his medical degree in May, 1792. The following September finds him back in Philadelphia. At first the going was hard and he had few, if any, patients.

In 1794 he became surgeon to the Pennsylvania Hospital, and professor of Surgery in the University of Pennsylvania (1805-18). With all his brilliancy and training he wrote nothing of great note. He introduced absorbable kid and buckskin ligatures, the use of the seton in ununited fracture, an operation for artificial anus, rest in hip-joint disease, and the invention of the tonsillotome. It is said he was the first to describe diverticula of the rectum, and the first American to wash out the stomach in cases of poisoning.

His reputation spread to all parts of his country and abroad. He had one of the largest and most remunerative surgical practices of his day.

Philip Syng Physick expired on December 15, 1837.

T. S. W.





[From Fernellius' *Unversa Medicina*, Geneva, 1679.]

BOOKSHELF BROWSING

WHAT EXPERIMENTAL ANIMALS HAVE CONTRIBUTED TO OUR CONTROL OF TUBERCULOSIS*

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IS *Tuberculosis Communicable?* This is a question that was debated for centuries. From the writings of the Greeks we learn that at some time earlier consumption was believed to be contagious, but that this belief had been abandoned. The Greeks apparently believed consumption to be a universal disease due to heredity and, therefore, that nothing could be done to prevent it. The Romans, however, did believe somewhat in the contagious nature of tuberculosis. Galen (131-201 A.D.) said: "Besides there is danger in being extremely intimate, especially in the conjugal relationship, with those who suffer from consumption and with all who give off putrid matter to such a degree that the room in which they sleep has a heavy odor."

Franciscus Sylvius (1614-1672) wrote: "The air expired by consumptives having been brought close to the mouth and nose, is drawn in and in this way offensive and irritating emanations are continuously carried from the affected party to others, especially relatives, and when these are finally infected with the same poison they also fall into phthisis."

A law which was passed in Spain in 1751 indicates that the contagiousness of consumption was taken very seriously. One of the regulations required the reporting of the disease by physicians, and provided severe penalties for failure to report.

In Italy a similar law was enacted in 1782. This provided further for thorough cleansing of premises and the destruction of clothing after a death from consumption, and the replastering of houses, the segregation of hospital linens, and other details growing out of the fear of contagion.

This law in Italy aroused much antagonism. In 1777, an article was published opposing the doctrine of contagiousness of consumption and trying "to expel from the public mind the radical error of this doctrine through which so many unfortunate sick people have been deprived of necessary aid and on account of which they have been abandoned in their distress and martyrdom."

By 1809 there was so much opposition that the chief magistrate of Naples consulted the medical faculty regarding the wisdom of keeping it on the statute books. There was a great diversity of opinion and

* From the Department of Preventive Medicine, University of Minnesota.

This is the first of a series of articles on THE VALUE OF ANIMAL EXPERIMENTATION IN MEDICAL PROGRESS. The next article will appear in an early issue.

the majority of the faculty were opposed to the law. However, the strongest men were in favor of it and the law continued to be at least partly in force, while the hostility toward it increased. In fact, Paganini, the famous violinist, while suffering from consumption in 1819, was thrown into the street from a hotel in Naples because the landlord so strongly believed in the contagiousness of the disease. A friend of Paganini's, however, passing by, saw the episode and not being convinced of the contagiousness of consumption stepped into the hotel and gave the landlord a sound thrashing. This friend then took Paganini and his equipment to a place where he received excellent care.

It is apparent, therefore, that for centuries the contagiousness of consumption was purely a matter of opinion. No scientific evidence was available. Many were suffering terribly because of the attitude of those who believed strongly in the contagiousness of the disease. At the same time, others with the disease were spreading it because of the protection from those who believed that the disease was not contagious. Turmoil reigned because of the lack of knowledge, knowledge which could be obtained in one way only, that is, by experimental methods.

HUMAN AND ANIMAL TUBERCULOSIS

It was not only human beings who were suffering from tuberculosis; animals were also suffering and dying. In fact, the Greeks and Romans had observed that consumption attacked animals, although they did not understand the relation between the disease in animals and that in man. Aristotle (384-322 B.C.) called the disease *scrofula*. In certain Hebrew books we find descriptions of the disease and provisions for excluding unhealthy meats from the diet. Agostino Bruno, who practiced medicine near Naples, believed consumption was contagious in animals. Gradually the idea arose that the disease in man and in animals might be the same. If it could be transmitted from one to another much might be learned about it.

In 1789, Kortum injected pus from a scrofulous patient into the neck of a boy. However, no disease was produced in the boy. A little later one investigator inoculated dogs with pus from scrofulous patients, and another one inoculated pigs; but in neither case did the animals develop the disease. This was perhaps the beginning of such work, though the technique was poor and the material inoculated was not the best for the purpose.

In 1843 Hermann Klencke (1813-1881) stated that he had been able to produce tuberculosis in rabbits by inoculating them with tuberculous material; and in 1846 he declared that tuberculosis could be transmitted by cow's milk.

SYSTEMATIC EXPERIMENTATION

In 1867, Jean-Antoine Villemin (1827-1892) published a book in which he gave the results of his extensive studies on tuberculosis during the previous years. This advanced our knowledge so much that it entitles its author's name to be placed on the walls of immortal fame. His work paved the way and it is almost unbelievable how the death rate and the incidence of tuberculosis have fallen in the brief time since Villemin's contribution was made. Into small wounds which he made behind the ears of rabbits, Villemin inserted fragments of tubercle taken from the bodies of people who had died of the disease. He later killed these animals, and in the majority found evidence of tuberculosis. In every instance a control animal was kept and killed at the same time as the inoculated animal; this rabbit was found to be free from tuberculosis. Next he transmitted it from rabbit to rabbit. He also produced the disease by inoculating tubercle and even sputum of man into guinea pigs, sheep and other animals. Thus the problem was solved. *Tuberculosis had been proved to be a contagious disease*, both for man and animal, yet many people long refused to accept the definitely established fact.

Although the work in the past had been splendidly done, particularly that of Villemin, it took something that could be visualized to convince many that the disease is in fact contagious. In 1877, Julius Cohnheim (1839-1884) and Salomonson carried out some ingenious experiments to prove beyond doubt that tuberculosis is contagious. They inoculated tuberculous material into the anterior chamber of the animal's eye, and there, through the clear cornea, they could see the development of tubercles from day to day. This work was confirmed by others in the next four or five years and thus it became well established that *there is something in tuberculous material which is capable of growing when inoculated into the bodies of healthy animals*. What could this be? It must be something extremely small because inoculation of very minute particles of tuberculous material produced disease.

MAKING THE CONTAGION VISIBLE

The microscope had been developed and at that time so well perfected that objects could be magnified several hundred times. It was this instrument which made the next step possible. Already it had helped to show that anthrax, relapsing fever, leprosy, typhoid fever, chicken cholera and other diseases were caused by minute living organisms.

Robert Koch (1843-1910), a country practitioner, took tuberculous material from the lungs of animals, properly prepared it, placed it under the microscope and saw large numbers of very small rod-shaped organisms. He felt that these must be the cause of tuberculosis but he did not have sufficient proof. He next applied various dyes to them and finally found they had the peculiar quality of retaining acid dyes when other organisms in the same field yielded up the dyes under a certain chemical treatment. He noticed that those organisms which retained the dyes were constantly present in tuberculosis and appeared to be the same small, rod-shaped structures that he could see

without the use of dyes. His next step was to isolate this microorganism and grow it in pure culture. Previous to his time no nutrient had been found suitable for growing this particular kind of microorganism. Koch therefore searched for some time to find a medium upon which it would grow in pure culture. When he had one which he believed would be satisfactory, he placed upon it material from tuberculous processes, then placed it in an incubator with a temperature closely approximating that of the human body.

Koch was patient, he watched these preparations day after day. As time passed, he began to see developing on the culture media small whitish points. Taking a little of this material and placing it under the microscope, he brought to his vision the small rod-shaped microorganism he had seen from the original tuberculous material. Staining these organisms, he found that they had the same characteristics as those observed in the original tuberculous material. Thus he had grown them in pure culture; but how was he to prove to the world that these actually are the cause of tuberculosis? There could be just one way, and that was to inoculate this pure culture which he had grown artificially into the bodies of animals and see what happened. He then inoculated a series of animals and found tuberculosis developed in their bodies. Without the use of these animals the world would still be in darkness as to the true cause of tuberculosis, and the fight against the disease would in all probability be a losing one as it had been in all the past history of the world, instead of a winning one as it is at present.

VALUE IN DIAGNOSIS

The works of Klencke, Villemin, Cohnheim and Koch proved to be great steps in detecting disease earlier than it had ever been detected before, thus materially increasing the chances of recovery of people suffering from tuberculosis. In many cases it is not easy to find germs by the usual methods and resort to animal

inoculation makes diagnosis possible weeks before it could otherwise be made. In the early stages of the disease and before the tissues are badly broken down not many germs are being cast into the sputum. Moreover, the microscopic examination is made with an extremely small amount of sputum and the germs may therefore be entirely missed. If, however, a quantity of sputum or other suspected material is inoculated into the bodies of animals, even though only a few germs be present, they will multiply and cause disease in the animals' bodies, thus making it possible to determine the presence of disease. If germs are not present the animal is in no way injured or harmed, but if they are present the animal loses its life but human life is often saved. The following case illustrates this point.

A young man reported because he had recently expectorated some blood. Physical and x-ray examinations revealed an area of disease but it could not be determined with a high degree of certainty whether this disease was due to tuberculosis. The examination of the sputum by the usual method showed no evidence of germs of tuberculosis. It was important to know in this case because the treatment to be administered would depend upon whether or not the disease was caused by these germs. Some of the sputum was inoculated into the body of a guinea pig. In approximately two weeks a test was applied to this animal's skin; this showed that it had developed tuberculosis. A little later the animal was chloroformed and a post-mortem examination showed that it had unmistakable tuberculosis. This finding was sufficient and drastic treatment was quickly instituted. Many years have passed although the treatment is still being employed; this man was restored to good health and has had a splendid working capacity for a long time. The life of an animal was lost but the life of a man was saved.

Another need for definite knowledge as to whether or not tuberculosis exists in certain cases comes from our desire to protect other human beings from exposure to those who are capable of distributing the germs of tuberculosis. For example,

a mother reported for an examination because she had felt a little below par for some time. She had a slight cough. Ordinary methods of examination revealed no germs in the sputum. This mother was greatly worried about her children becoming infected. Her mind was much relieved when germs were not found by the usual method, but inoculation of sputum into a guinea pig proved beyond doubt that she was casting tuberculosis germs from her body. Knowing this, she immediately took measures to prevent the spread of the germs to her children, and at the same time to take the treatment which would help her overcome the disease in the shortest possible time.

There can be no doubt that by this simple procedure of animal inoculation thousands of human lives have been saved and extended, and that many thousands of others have been made happy because disease was prevented from entering their bodies. This is not a matter of opinion, it is a scientifically established fact.

Is Tuberculosis Curable? For centuries tuberculosis was held to be fatal in every case, because of general ignorance of the facts. Even today this idea is widely prevalent. We often hear it said, "once tuberculous, always tuberculous." This is not encouraging for the patient. Moreover, it is untrue. No one could confidently oppose the statement, however, until it had been scientifically proved untrue. Physicians had observed the complete recovery of people whom they believed to be tuberculous. Pathologists, at the post-mortem table, had seen many bodies containing old tuberculous processes that seemed well healed. But nothing except animal inoculation and careful study of the diseased tissue from day to day could prove how the disease healed.

Gardner of Saranac Lake inoculated guinea pigs with germs of tuberculosis which had lost much of their virulence through long growth and special treatment. These cultures did not kill the guinea pigs although they did produce definite disease.

As the disease developed and went through its various stages, Gardner killed the animals one by one by a painless method. With a magnifying glass he located in the lungs the diseased areas, removed them, and studied them in a most detailed manner with the microscope. By this work he proved beyond doubt that *the animal's body is capable of developing definite tuberculous disease and then healing it so completely as to leave almost no trace of its former existence.* This fact well established makes it possible for the patient and those responsible for his care to take heart and look forward to the time when his disease may be completely overcome.

TYPES OF TUBERCULOSIS GERMS

There are three types of tuberculosis germs. They are the *human*, *bovine* or *cattle*, and the *avian* or *bird* type. The human type most commonly causes the disease in man. The bovine type is not uncommonly found as a cause of disease in man. The avian type causes disease in man very rarely.

All of these types of tubercle bacilli appear exactly the same when studied under the microscope but when inoculated into the bodies of animals each shows distinctive characteristics. For example, the human type produces serious disease when inoculated into the bodies of guinea pigs, and only very mild disease when inoculated into the bodies of rabbits. The bovine type causes very serious disease when inoculated into the bodies of rabbits, and only mild disease when inoculated into the bodies of guinea pigs. The avian type produces serious disease when inoculated into the bodies of fowls and very slight or no disease in the bodies of guinea pigs and rabbits. Animal inoculation therefore serves to differentiate the germs.

In some cases of tuberculosis in man it is very important to know which type of germ is the cause of the disease, because this materially affects the treatment as well as the ultimate outlook for the patient. In such cases it is necessary to inoculate

animals and thus determine accurately the type of germ present. Again, in obscure cases such animal inoculations may lead to the detection of the disease.

For example, in a man who had been ill for some time there was evidence of disturbance in one of the kidneys. The exact nature of the trouble could not be determined. Tubercle bacilli in the urine could not be seen with the microscope. Guinea pigs were inoculated and later developed tuberculosis, thus proving that the kidney was tuberculous.

It is a well-established fact that when tuberculosis exists in one kidney the best treatment is removal of that organ, for if allowed to continue, the disease is very likely to find its way to the bladder and later to the opposite kidney, and eventually the patient's life is lost. In this case, a few pigs lost their lives, but a human life was saved.

In testing out new methods of treatment, or methods of prevention, the animal is of wonderful service. A treatment which may seem perfectly rational is best applied to animals first, in order that the effect may be thoroughly studied and well understood before it is applied to the human body and in order that the dosage may be standardized. If there is an element of danger in the proposed remedy or treatment, this will be learned. On the other hand, if it is worthless so far as the treatment of disease is concerned, this will also be learned. Many times in the history of the treatment of tuberculosis this method has been used with great saving to human beings.

Is Tuberculosis Preventable? Of course it is the prevention of tuberculosis that we are all seeking. How can the human body be rendered immune to the disease? This is a burning question at present and a good many people in various parts of the world are trying to answer it. From Paris have come reports that a method has been devised whereby the mortality of tuberculosis among infants has been reduced. These reports are from the laboratories of one of the world's out-

standing authorities on the subject. He believes if the method is so perfected that it can be applied to older children and adults the future will be bright for the prevention and eventual eradication of tuberculosis.

How was this method devised? It was through the use of experimental animals. Albert Calmette took tubercle bacilli of a certain strain and grew them artificially in incubators over long periods of time. By so doing he reduced their virulence and finally had so changed them that when they were inoculated into the animal's body they did not produce disease but did produce *tuberculin*, which he believes stimulates the formation of protective elements in the body and keeps them active and ever ready to fight virulent strains of tubercle bacilli, in case they gain entrance.

Similar work is being carried out in this country where herds of cattle are being used experimentally. These animals are well fed and kept extremely well nourished, they suffer no pain, enjoy eating like other animals, sleep and rest as other animals do, and are not being harmed; yet they are being experimented upon, and a great deal is being learned. Whether Calmette's method is of great value in preventing tuberculosis or whether it is harmful to the body should be proved through the use of experimental animals.

PNEUMOTHORAX

In recent years surgery has come to the rescue in the treatment of tuberculosis of the lungs. In fact, it has come to be one of the outstanding methods of treatment in certain types of cases. By it a diseased lung is collapsed, thus putting it at rest, and the tuberculous disease is thereby brought under control. This is not a matter of theory but of actual practice, and the results obtained fully justify the operations employed. These procedures were developed through operations performed on many animals, to determine just how much

could be done with safety and what results could be obtained under different conditions. When these were determined more animals were used by surgeons in perfecting this technique, that is, in developing such skill that surgeons may quickly and safely operate on the human chest. This work with animals has made it possible to introduce in many places surgery of the chest with the least danger and with the greatest good to the patient.

TUBERCULOSIS AMONG ANIMALS

The experimental work on animals is not only of value to man but is proving of tremendous value to the various animal families themselves. The veterinarians are intensely interested in obtaining information concerning the control of tuberculosis since this disease makes such terrible inroads among animals. Careful investigation has shown that in some parts of this country a high percentage of the swine herds are infected with this disease, also that a high percentage of cattle have become infected. In fact, tuberculosis attacks nearly all animals in captivity. Experimental work which leads to more knowledge regarding the control and treatment of this disease, enables the veterinarians to prevent ravages among animals. Thus by the use of animals man has learned that:

- (1) Tuberculosis is a contagious disease.
- (2) Tuberculosis is caused by the tubercle bacillus.
- (3) Tuberculosis can be detected by animal inoculation.
- (4) Tuberculosis heals well under proper conditions.
- (5) Tuberculosis in some forms may be treated successfully by surgery.
- (6) Tuberculosis is preventable.

To learn these facts and to have them scientifically established has required the use of many experimental animals. To the human family this has meant the saving of many thousands of lives, to say nothing of the suffering and sorrow it has prevented.

MEASURABLE GAINS

About 1843 when Klencke proved that tuberculosis is communicable, the death rate from tuberculosis was approximately 450 for every 100,000 people living. Now the rate is approximately 88 for every 100,000 people living and we may expect that this rate will be still further reduced; but it will require the use of more animals to yield new facts about the disease and its treatment before it is reduced to the humanly attainable minimum.

EXPLOITING ANIMALS

Most of the animals which man raises are raised for a purpose. Swine are raised in large numbers only to be driven to the slaughter houses, to be stuck with a huge knife and the life blood allowed to flow away. The carcasses are then prepared and placed upon the market to supply man's need for food. Cattle are raised in large numbers to be shipped to the slaughter houses, struck with a sledge hammer and the carcasses then placed on the market

and sold for food. In both cases lives of animals are taken prematurely; yet they were raised by man for the purpose of supplying food.

Animals such as guinea pigs and rabbits used in the experimental study of tuberculosis are also raised for a purpose. They are brought into the world for no other reason than what they can contribute to the fight against disease. They are well cared for and not allowed to suffer. It is true that some of them die untimely deaths just as the swine and cattle do, but in many instances they contribute far more to man's welfare than those animals whose carcasses are used for food.*

* Animals in a "state of nature" die "prematurely" in far greater proportions than is the case among domesticated or laboratory animals. It is obviously impossible for all the individuals who are born to survive to maturity. It is therefore a rather crude and unenlightened sentimentalism that focusses attention upon those premature deaths and even the sufferings of domesticated animals (including laboratory animals) and at the same time disregards the vastly greater suffering and death that would obtain both among beasts and among humans but for our "artificial" interventions—including animal experimentation. [Ed.]



BOOK REVIEWS

IMHOTEP TO HARVEY. BACKGROUNDS OF MEDICAL HISTORY. By C. N. B. Camac, M.D. N. Y., Paul B. Hoeber, Inc., 1931.

Whether you are ready for an advanced course in medical history, a beginner just feeling your way, or read medical history for the momentary pleasure it gives, you will enjoy and find Doctor Camac's book a gem.

Medical history, closely associated with that of education and science, is given in outline. Biography is not given, that being left to the reading suggested from time to time throughout the pages. The author draws attention to the fact he "has drawn the picture in large strokes."

The chapters comprise: The Evolution of Inquiry, Before the Greeks, Greek and Graeco-Roman Medicine, Middle Ages: Period of Retrogression for Science, Islamic or Arabian (Mohammedan) Medicine, Middle Ages (Continued): Universities and the Pre-Renaissance Period, The Renaissance, Environment of the Inquirer in the Medieval and Renaissance Periods, The 17th Century; The Beginnings of Modern Science, Schools of Thought in Medicine, The Greek Emblem in Medicine. Historic Records. The book ends with a List of Books on medical history and its many phases.

Doctor Henry Fairfield Osborn wrote the Foreword.

Our reaction after reading this book was: "delightful."

PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D.

AND

LOYAL DAVIS, M.D.

SECOND INSTALLMENT

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CHAPTER IV

EXAMINATION (*Continued*)

IV. SUBJECTIVE SENSORY DISTURBANCES

Excluding causalgia, *pain* does not often result from injury of a nerve itself after the initial trauma. In our series, where pain has been present it has been boring, aching and rarely stabbing in character. Often it is found in cases in which the wound has been infected or when débridement with secondary suture has been performed, or when foreign bodies have been present. It commonly is worse at night and in the dependent position, and at times it is evoked by movement.

Paresthesias, pain and hyperesthesia were observed in what seemed to us to be a surprisingly small number of cases. From an analysis of 600 cases seen some months after injury, 161 cases were found to have sufficiently striking evidence of these to warrant a description in the history. Paresthesias were noted to have occurred in 62 patients. Mild paresthesias may be present at some time in many cases although the numbness complained of cannot be so classified because often it signified only a recognition of anesthesia. In patients seen immediately after injury the severe symptoms of coexisting diffuse injuries to other tissues often mask a mild paresthesia. At the time of injury the patient may experience pain described variously as pins and needles, an electric shock, a stab, lightning pain or as if the "crazy bone" were struck. This may be referred to the distribution of the nerve, but only too frequently the shock is so great that it masks such a symptom. Very frequently in the absence of shock or serious damage to other parts no particular referred sensation is observed, especially when a nerve is cut through, and this is usual in those wounds due to sharp instruments.

It is likely that the pressure of work in base hospitals, as well as the aforementioned concomitant injuries, explains the frequent absence from the records of some 500 patients seen

soon after injury, of a notation of the presence of subjective sensory disturbances. In all, less than 50 are so recorded. Of these, injuries to the sciatic nerve have the greatest number (20). Pain is seldom complained of with the exception of a few cases of causalgia. Hyperesthesia predominates and anesthesia is seldom mentioned. Many of these cases undoubtedly develop subjective sensations later since it was noted that causalgia, and, indeed, other sensations, appeared with the return of some function. When complete physiologic interruption still existed, subjective disturbances were rare. On the other hand, in such cases as were seen a few weeks after injury, especially the few patients who developed causalgia, very troublesome and constant pain was complained of. A characteristic note is as follows: "One month after injury formication and tingling over the ulnar distribution developed and gradually increased so that it was most severe two months after injury, since when the sensation has diminished considerably." Or: "At the seventh week formication appeared in the thumb and index finger; at the same time motion began to improve."

Some time after injury severe and persistent formication, pins-and-needles sensations, prickling, crawling and stinging sensations were relatively rare despite the accepted statement of their common occurrence. Naturally, such formication as occurs from manipulation, compression or striking an extremity and thus producing stimulation of the wildly growing axones in a neuroma must be excluded from such cases of spontaneous paresthesias. These spontaneous sensations occurred in 30 cases of sciatic nerve injury, in 13 of the peroneal, 4 of median, 8 of ulnar, 8 of radial, 4 of ulnar and median and 5 of brachial plexus injuries. In only 6 cases of complete section of the sciatic nerve was this observed. This latter observation holds true in a relative manner for the other nerves, not only for paresthesia but for pain as well. For example, only 2 of 15 cases of median nerve lesions giving a history of pain were thought to be complete lesions and in these the loss of pain sense represented a smaller area than is

commonly found. In ulnar nerve lesions the severe cases showed an equal number complaining of paresthesias but this was an exception. Although paresthesias occurred often in the presence of pain, usually only hyperesthesia was associated with the burning pain which will be described later. True tactile hyperesthesia rarely is encountered in peripheral nerve lesions. When stimulating a hairy part it may appear in an area of overlapping function.

An excessive reaction to painful stimuli evoking that peculiar sensation which has been ascribed to the protopathic fibers is constantly found in areas of overlap when sensation to pain has returned and anesthesia is present. It consists of a marked and quick withdrawal of the extremity which cannot be inhibited and is associated with a sensation of diffuse, unpleasant pain. This protective mechanism expressing a deficiency of sensation has been called a hyperalgesia but it is more properly classified as a reaction *sui generis*, as already pointed out by Head.

Hyperesthesias were more frequently observed than pain in the cases seen soon after injury. They were noted 17 times in the 42 cases of sciatic nerve lesions with subjective sensory disturbances; in 4 of 22 cases of peroneal injury; in 6 of 15 cases of median; in 3 of 23 cases of ulnar; in 3 of 13 cases of radial; in 4 of 16 cases of ulnar and median; and in 5 of 14 cases of brachial plexus injuries. In lesions of the nerves of the upper extremity they were observed in only 3 instances where the median nerve was not injured at some time in addition to the nerve remaining paretic. In the lower extremities only 2 cases occurred where the tibial may not have been injured as well as the peroneal.

Pain exclusive of causalgia does not often result as a consequence of a peripheral nerve lesion after the initial trauma. Concomitant lesions of the blood vessels, considered by some as a common source of pain, have not been found by us to be a constant factor in its production. In 16 severe lesions of the arteries, chiefly of the upper extremities, patients

complained of pain, varying from a dull ache to burning pain. However, the patients who suffered the greatest pain were those in whom the median nerve was injured.

Pain exclusive of causalgia was noted 25 times in the 42 cases of sciatic nerve lesions; 5 times in 22 peroneal injuries; 9 times in 15 median injuries; in 7 of 22 ulnar injuries; in 5 of 13 radial; in 7 of 16 ulnar and median; and in 7 of 14 brachial plexus lesions. It is again significant that in 3 of the cases of ulnar nerve lesions the median had been injured as well and function had recovered. In 2 of the radial nerve lesions the same circumstance had existed, and in all of the brachial plexus lesions the median was involved. Similar observations are true of the lower extremities with respect to the tibial nerve. In only 2 cases of median nerve lesions was there any possibility of a complete section of the nerve, and all of the brachial plexus lesions were recovering, or partial lesions. Only 5 of the 42 cases of sciatic lesions which produced pain were complete lesions. In general, as with paresthesia and hyperesthesia, pain was observed largely in incomplete or recovering lesions.

A study of the distribution of subjective sensory disturbances in sciatic nerve lesions and in combined lesions of the nerves of the upper extremity shows that when the median or tibial nerves were involved as well as some other nerve, the area supplied by them was more frequently the seat of such disturbance. In 23 lesions of the ulnar and median the area of the median nerve and the combined areas of both were the seat of subjective disturbances in 16 cases. The tibial nerve distribution alone was the area involved in 42 cases of sciatic nerve lesions.

The character of the pain varies from an ache to a boring, rarely stabbing, pain. It may be a soreness or a throb, occasionally a stinging pain. Usually it is increased after exertion. At times it is constant, with exacerbations brought on by movement and pressure, unusual position or stretching. The aching and boring is undoubtedly worse at night and with

the extremity in the dependent position. The outer surface of the foot, the plantar arch, the outer surface of the leg and calf are favorite locations. In the upper extremity, the palm, the thenar eminence, the index finger, the ulnar border of the hand, the dorsum of the forearm and, at times, the outer surface of the forearm are places of selection. Occasionally, pain is felt at the wrist joint in ulnar nerve lesions, at the elbow in radial injuries and at the head of the fibula in sciatic nerve lesions.

CHAPTER V

EXAMINATION (*Continued*)

V. CAUSALGIA

In 1813, Alexander Denmark reported the case of a man wounded by a bullet which entered $1\frac{1}{2}$ inches above the inner condyle of the humerus. The wound of exit was on the lateral side in front of the elbow joint. "He complained of a burning pain beginning at the extremities of the thumb and fingers, except the little one, and extending to the wound in the arm. The pain was of a burning nature and so violent as to cause continual perspiration from his face. He had an excoriation on the palm from which exuded an ichorous discharge."

Hamilton in 1838 described the glossy skin which is a part of the syndrome, and Paget completely described this condition in 1864. Wier Mitchell, Morehouse and Keen in the same year reported a series of cases under the name of causalgia. Mitchell's description is so comprehensive that it may be generously quoted, not alone for its historic interest but for its clinical value as well.

The seat of burning pain is very various; but it never attacks the trunk, rarely the arm or thigh, and not often the forearm or leg. Its favorite site is the foot or hand. In these parts it is to be found most often where the nutritive skin changes are met with; that is to say, on the palm of the hand, or palmar part of the fingers, and on the dorsum of the foot; scarcely ever on the sole of the foot or the back of the hand. Where it first existed in the whole foot or hand, it always remained last in the parts above referred to, as its favorite seats.

The great mass of sufferers described this pain as superficial, but others said it was also in the joints, and deep in the palm. If it lasted long it was referred to the skin alone.

Its intensity varies from the most trivial burning to a state of torture, which can hardly be credited but which reacts on the whole economy, until the general health is seriously affected.

The part itself is not alone subject to an intense burning sensation, but becomes exquisitely hyperesthetic, so that a touch or a tap of the finger

increases the pain. Exposure to the air is avoided by the patient with a care which seems absurd, and most of the bad cases keep the hand constantly wet, finding relief in the moisture rather than in the coolness of the application. Two of these sufferers carried a bottle of water and a sponge and never permitted the part to become dry for a moment.

As the pain increases, the general sympathy becomes more marked. The temper changes and grows irritable, the face becomes anxious and has a look of weariness and suffering. The sleep is restless and the constitutional condition reacting on the wounded limb, exasperates the hyperesthetic state, so that the rattling of a newspaper, a breath of air, another's step across the ward, the vibrations caused by a military band, or the shock of the feet in walking give rise to increase of pain. At last the patient grows hysterical, if we may use the only term which covers the facts. He walks carefully, carries the limb tenderly with the sound hand, is tremulous, nervous, and has all kinds of expedients for lessening his pain. In two cases, at least, the skin of the entire body became hyperesthetic when dry, and the men found some ease from pouring water into their boots. They said, when questioned, that it made walking hurt less, but how or why, unless by diminishing vibration, we cannot explain. !

One of these men went so far as to wet the sound hand when obliged to touch the other, and insisted that the observer should also wet his hand before touching him, complaining that dry touch always exasperated his pain.

The relation of burning pain to altered nutrition in the skin was fully described by Mitchell:

The skin affected in these cases was deep red or mottled, or red and pale in patches. The epithelium appeared to have been partially lost, so that the cutis was exposed in places. The subcutaneous tissues were nearly always shrunken, and when the palm alone was attacked, the part so diseased seemed to be a little depressed and firmer, and less elastic than common. In the fingers there were often cracks in the altered skin, and the integuments presented the appearance of being tightly drawn over the subjacent tissues. The surface of all the affected part was glossy, and shining as though it had been skillfully varnished. Nothing more curious than these red and shining tissues can be conceived of. In most of them the part was devoid of wrinkles and perfectly free from hair.

Mr. Paget's comparison of chilblains is one which we often used to describe these appearances; but in some instances we have been more strikingly reminded of the characters of certain large, thin and highly polished scars.

Nothing fundamental has been added to this description by the experience of the late war. Inasmuch as a large material is rare in civil practice, it is impossible to say whether the commonly accepted statement that causalgia is more often encountered in warfare is correct.

There is some confusion as to what constitutes a case of causalgia and many cases of burning pain have been recorded which do not correspond in all details to Wier Mitchell's description.

The almost constant association of glossy skin with burning pain led Wier Mitchell to believe that the burning itself depends for existence upon some nutritive alteration of the ultimate extremities of sensory nerves, although burning pain was encountered by him in numbers of men without glossy skin. Head has felt that the term "glossy skin" should be applied only to such cases as were described by Paget and Wier Mitchell, and is not to be confused with atrophic conditions not infrequently resulting from division of a peripheral nerve. Experience in the late war, however, has pointed out the existence of varying degrees of burning pain, and although some cases are associated with glossy skin many are not. Again, there occurred a considerable number of cases of glossy skin without burning pain. The predilection of these symptoms in the distribution of the median and sciatic nerves makes it probable that these nerves under certain conditions of pathology may produce glossy skin and burning, either alone or combined.

In our material of 1020 cases glossy skin not associated with causalgia was described in 41 cases; 15 of which accompanied median; 19, sciatic; 3, peroneal; 3, ulnar; and 1, radial nerve injuries. Pain in general was uncommon, whereas some form of paresthesia was found in about half of the cases. Contrary to Bénisty, who believes that glossy skin results from vascular lesions, these were very rarely noted in this group. On the other hand, of 38 cases of burning pain but 8 were accompanied by glossy skin. It may be noted in this connection, however, that in many of these recovery was taking place and the pain had diminished materially. In many instances severe burning

pain has been designated as causalgia, whereas moderate, or slight, burning pain, although possibly due to the same conditions, have not been so classified. As a result, statistics have only a relative value in this connection.

The pathogenesis as well as the pathology of this disorder is unknown. Many speculative theories have been proposed. Stopford has found partial division of the nerve and intraneural fibrosis, but identical changes have been observed in many nerves which did not produce the disorder. He believes that a secondary arterial thickening consequent upon injury to the vasomotor nerves is responsible for the symptoms. Leriche raised the question as to whether the condition is not due to a neuritis of the periarterial sympathetics. Meige and Bénisty believe that we are concerned with an inflammation of the fibers of the sympathetic system which follow the nerve trunks themselves and supply the glands, capillaries and nerve endings of the different layers of the skin.

Of the 161 cases showing subjective sensory disturbances, 38 cases of burning pain were found. Some doubtless would not ordinarily be classified as causalgia. On the other hand, it is significant that 33 of these cases occurred in patients who had either median or tibial nerve lesions alone or combined with some other nerve. Four cases occurred in ulnar nerve lesions and none in peroneal nerve lesions. Burning pain occurred in 8 of the 42 cases of sciatic nerve lesions; in 3 peroneal, 2 of which were residual from a former sciatic nerve lesion; 6 of the median nerve; 8 of the combined ulnar and median, 4 of which were residual from a median nerve lesion; in none of the radial nerve cases; in 3 of the brachial plexus lesions which involved the median, and in 2 posterior tibial nerve lesions. In only one case, that of the ulnar nerve, was there a complete lesion when burning pain was present. It is very likely that all patients who complain of burning pain, mild or severe, with or without glossy skin, are suffering with a certain grade of causalgia. The condition occurs most frequently in injuries of the median and sciatic nerves, occasion-

ally in the ulnar and usually when associated with the median, and very rarely in the radial nerve.

When the median nerve is affected the position of the hand



FIG. 27. Causalgia in a median nerve lesion.

is characteristic. It is held in a position wherein it is protected from jars, a dependent position, and stretching. The forearm is usually flexed, the fingers extended, at times hyperextended at the proximal phalanges, and the thumb is adducted. The hand appears slender, the fingers thin and tapering. The skin is fine, pink in the palm and often stretched and white on the dorsum. Blisters and papules often appear on the palm.

Constant wetting leads to maceration, with superficial ulcers. The nails are convex, pink, at times rapidly growing and curved inward. Longitudinal and transverse ridges in the nails are common. The finger tips become swollen and at times slightly clubbed. Commonly perspiration is diminished over the palm but increased over the dorsum, although in some cases perspiration is increased and appears in large beads over the radial side of the palm. (Fig. 27.)

The motor paralyses are slight, although some paresis is present in all cases, particularly in the small hand muscles. The painful character of the lesion prevents an accurate estimate of the actual motor deficiency because active movements are performed reluctantly. Slight irregular tremors and twitchings are common in the thumb and forefinger. Interphalangeal fibrosis and ankylosis are common and frequently an ankylosis occurs in the wrist joints in flexion.

The sensory disturbance is most prominent and commonly begins several weeks after injury, although some cases have been observed immediately after. It rarely affects the arm or thigh and not often the forearm or leg. Its favorite site is the foot or hand, the palm or palmar surface of the fingers, the root of the thumb and index finger. The third interosseous space, the inner side of the middle finger and the outer side of the ring fingers are often pointed out as the most painful spots. Although Wier Mitchell seldom found it over the sole, this has been the site of election in our cases. It often affects the tip of the toes and at times the dorsal surface of the proximal phalanges (Fig. 28).

The pain is described as piercing, throbbing, grinding, dragging, stabbing and burning. Paroxysmal exacerbations of a constant pain are characteristic. They are induced by physical and emotional causes. Exposure to air, dry heat, noise, bright lights, jarring from coughing, sneezing, laughing and the dependent position are common causes. As Wier Mitchell pointed out, emotional causes are common. Seemingly trivial experiences, such as meeting a relative, a physician's visit, the

witnessing of a quarrel or a surprise, may provoke a paroxysm. In aggravated cases the patient becomes shut-in, avoids society, cannot bear the laughter of fellow patients and remains



FIG. 28. Causalgia in a tibial nerve lesion.

in his bed in an attitude of defense. Relief from the burning pain is sought in the application of wet compresses, and the phobia to dryness spreads to other parts of the body. The phenomena noted by Wier Mitchell have been designated as synesthesalgia by Souques. In this condition touching the hand opposite the injured one, walking on dry feet, combing the hair, or even seeing another touch a dry object, provokes a paroxysm of pain. A curious case has been described by Fuchs, in which the burning pain was felt in the right hand in a left median nerve lesion.

Objective sensory disturbances vary. Hyperesthesia toward heat and cold is always present. Tactile sensibility is difficult to test either because of the hyperhidrosis or insistence upon keeping the extremity wet. Stimulation with an algesiometer produces a type of hyperalgesia which is similar to the protopathic response found in areas of overlap, and probably conceals a hypalgesia. It is often found that firm pressure produces less hyperalgesia than a light touch. Stereognostic sense is greatly impaired, and sense of position and vibration is disturbed.

The condition reaches its height four to five months after injury and tends to disappear slowly. Many cases so continue for a period of two years.

CHAPTER VI

EXAMINATION (*Continued*)

VI. OBJECTIVE SENSORY DISTURBANCES

When a sensory or mixed nerve is physiologically or anatomically interrupted, loss of sensation occurs. Sensation may be lost wholly or in part. It may be lost for some or all types of sensibility.

Complete loss of sensation is properly termed *anesthesia*. Ordinarily this term is used to signify any degree of blunted sensation and is qualified by such adjectives as partial, complete or slight. It is limited further by such definitives as muscle anesthesia, tactile, thermic and joint anesthesia. The loss of the sense of pain is called *analgesia*, and this word may be qualified in a similar manner. By some authors the partial loss of temperature sense is called thermo-anesthesia and complete loss, thermo-analgesia. The former term may be applied more properly to the loss of appreciation of slighter changes in temperature; the latter to greater ones (epicritic and protopathic).

The examination of sensation, although simple, must be critical and painstaking. It should be made with the patient relaxed and comfortable. The extremity to be examined should be properly supported. The skin must be warm and, if hyperhidrosis is present, dried. Distracting noise or activity must be eliminated. Care should be taken to avoid fatigue and the patient should be permitted to rest a number of times during the examination.

The mental capacity and state of the patient must be kept in mind in evaluating the results. Apprehensive patients suffering with painful lesions are very apt to answer haphazardly and rapidly to shorten the ordeal. Attention frequently is difficult to hold and the patient's replies become stereotyped. It is necessary to guard against this by questions relating to the character of the sensation and its location. A

suggestion such as "Is this sharp?" should be avoided. It is better to ask, "What do you feel?" and "Where?"

The border of sensory loss may be determined by beginning the examination over the normal skin and approaching the anesthetic area. This is checked by beginning over the anesthetic area and entering the normal one. The borders obtained will not coincide exactly because in the latter instance attention is more readily held.

Diminution of sensation frequently results from changes in the soft parts exclusive of the nerves. For example, stretching of the skin as the result of hemorrhage, edema, or inflammatory changes, cyanosis and vascular lesions with consequent fibrosis of tissues, all produce sensory loss. Such loss is not limited to the sensory distribution of any one or more peripheral nerves. No areas of overlap can be made out. Frequently in the middle of an anesthetic area normal sensation is found. Peculiar dissociations, such as loss of pain and preservation of touch may be found. The skin over the body is not equally sensitive. This is true for all types of sensation. In general, it may be said that the arm and thigh are least and the tips of the fingers most sensitive. Thickening of the skin, calluses and failure of desquamation of the skin all diminish sensory activity, and due consideration must be paid to such conditions.

Touch or tactile sensibility may be tested for by a wisp of cotton. Simple methods of examination are best, and methods employed in physiologic research, such as v. Frey's hairs, need not be used. All hairy surfaces must be shaved several hours before examination. The degree of pressure must be varied somewhat in relation to the thickness of the skin tested, especially in the palms, soles and dorsal surfaces of interphalangeal joints. The pressure must be very light, insufficient to produce any indentation of the skin and thereby stimulation of deep sensation. Such methods as touching the skin with a blunt object, as a pencil, evoke deep sensibility and not touch sense. Two point discrimination sensation, although of physiologic interest, offers no valuable clinical date.

Although areas of analgesia may be found by examination with a pin or needle, more accurate methods are preferable to determine accurately the borders of loss of pain sense and to



FIG. 29. Simple algesiometer.

follow the progress of sensory change from day to day. When areas of sensory loss are to be compared from time to time it is necessary to employ stimuli of known degree. Varying the degree of pressure produces different sized areas of sensory loss, and if low degrees of pressure are used the loss of touch and pain may be coextensive. If higher degrees of pressure, 5 to 10 grams, are employed the area of the loss to touch is far greater than the loss of pain.

A simple and accurate algesiometer may be constructed by placing a large headed pin in the barrel of a glass syringe, allowing the point to extend through the tip and replacing the plunger (Fig. 29). The weight of the plunger determines the degree of pressure when the pin is allowed to prick the skin, with the syringe held by the barrel. Various sized syringes may be used, varying degrees of pressure being thereby employed. It is important to distinguish between that sensation which is normal and that which arises in areas of nerve overlap to be described later. In the latter there is evoked a painful though

not necessarily sharp sensation, which is diffuse and difficult to localize. Sharpness and pain are not synonymous. (Fig. 30.)

Temperature sense must be tested for by relatively inaccu-

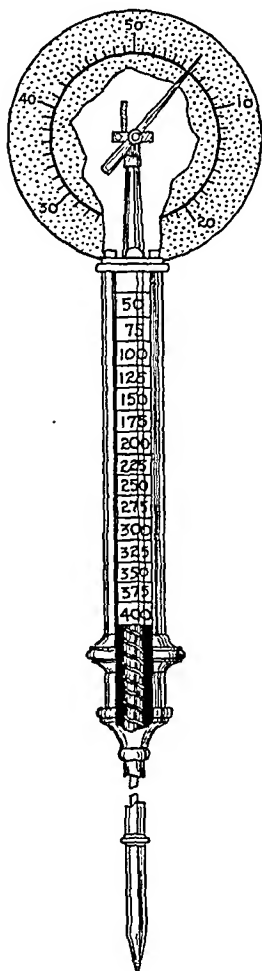


FIG. 30. Standard algesiometer.

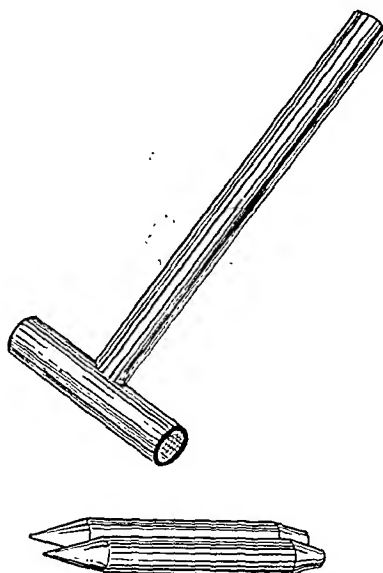


FIG. 31. Cylinders for testing temperature sensation.

rate methods, such as test tubes which contain water of known temperature or, preferably, metallic cylinders which may be heated or chilled (Fig. 31). A rapid method of determining accurately the borders of loss of sensation to low degrees of temperature is the stimulation of the skin by a pledget of cotton twisted to a point and moistened with ether. As with

pain, so with temperature, stimulation and higher degrees of cold and heat stimulate the protopathic sensibility, and frequently in the areas of overlap the sensation evoked is

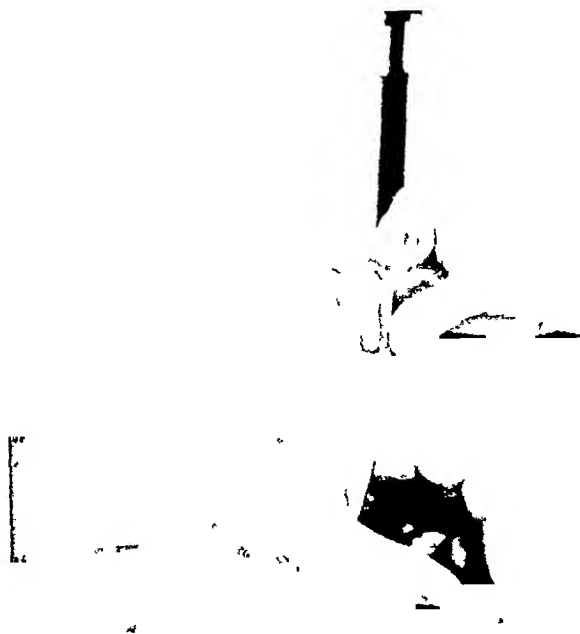


FIG. 32. Method of testing for bone vibratory sense.

unpleasant, painful and diffuse, in contrast to the actual temperature perception in a normal area.

Although Head's theory of the existence of separate nerve endings for protopathic, epicritic and deep sensibility is controversial, from a clinical standpoint it is useful to preserve some such classification. It is certain that with clinical methods these several sensations disappear and reappear in certain areas in a regular order.

Similar to Head's classification of cutaneous sensibility, J. S. Stopford divides deep sensibility into that "recovering" early (contact of pressure and pressure pain) and that recovering late or imperfectly (recognition of movement of a joint and localization of pressure). Contrary to former opinions, he

believes that the principal innervation of the deep tissues is by nerve fibers which arise from the main trunks and pass directly to the end organs. The supply by fibers which accom-

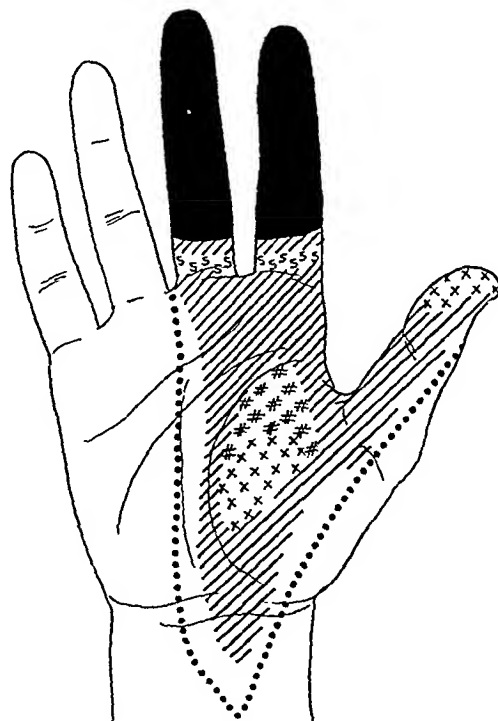


FIG. 33. Algometer.

pany the motor branches and pass to their final distribution along tendons seems to be only supplementary.

The importance of the recognition of nerve overlap, which will be considered in detail later, is greater in the case of deep sensibility than of cutaneous sensibility. Unless the area of

isolated supply of a nerve for deep sensibility is known, and only that loss which is found within the limits of this area used as an indication of sensory loss, the conclusions will be mis-



■ = Loss of pain, touch and temperature

/// = Loss of touch

.... = Loss of temperature

= Hypalgesia

s = Hypaesthesia

x = Analgesia

FIG. 34. Key for use in recording changes in sensation.

leading. As with cutaneous sensibility, so here, it is for that quality of sensation which returns early (pressure, contact and pain) that the greater overlap exists.

Deep sensibility including osseous sensibility may be tested by vibrations of a tuning fork (Fig. 32). This sensibility

is lost over that part of the bones usually innervated by the isolated sensory supply of the skin overlying them. Sense of contact of pressure should be tested by an algimeter (Fig. 33) with pressure insufficient to evoke pressure pain. The finger or a blunt instrument may be used. Sense of passive movement or tendon sense may be tested by passively moving the segments about a joint of an extremity which is supported and relaxed and having the patient repeat the movement on the opposite side and accurately describe it. Sense of position, or muscular sense, is tested by moving segments about more than one joint and after the movement has been completed and the extremity is at rest having the patient assume a similar position upon the opposite side. A simple key for charting changes in sensation is presented in Figure 34.

CHAPTER VII

EXAMINATION (*Continued*)

VII. NERVE OVERLAP

For many years it has been noted that total loss of sensation after complete division of a peripheral nerve is limited to a much smaller area than we would expect from its anatomic distribution. Likewise, it has been observed that following injury of a peripheral nerve sensory symptoms may rapidly diminish, and at times the loss of sensation to pin prick may be absent entirely. That severe widespread anesthesia results only from trauma of several nerve trunks of a plexus has generally been accepted. Lesions of single nerves result in partial anesthesia or, if a severe anesthesia is present, the area of complete loss of sensation rapidly shrinks.

Many attempts have been made to explain these phenomena. Among the older theories were: (1) that nerve fibers grow from healthy surroundings into the insensitive parts; (2) that after section of a nerve, stimulation of the severed part may pass through an accessory branch into an adjacent nerve and reach the major branch of the injured nerve above the lesion through a second lateral branch (collateral innervation—Létiévant); (3) that numerous anastomoses connect the peripheral ramifications of sensory nerves, so many cutaneous areas receive their innervation from different nerves. All these opinions have undergone important changes since the investigations of Head and his co-workers. The results of their brilliant studies led Head, Rivers and Sherren to conclude that:

The sensory mechanism in the peripheral nerves consists of three systems:

1. Deep sensibility, capable of answering to pressure and to movement of parts and even capable of producing pain under the influence of excessive pressure, or when the joint is injured. The fibers, subserving this form of sensation, run mainly with the motor nerves, and are not destroyed by division of all the sensory nerves to the skin.

2. Protopathic sensibility, capable of responding to painful cutaneous stimuli and to extremes of heat and cold. This is the great reflex system, producing a rapid widely diffused response, unaccompanied by any definite appreciation of the locality of the spot stimulated.

3. Epicritic sensibility, by which we gain the power of cutaneous localization, of discrimination of two points and of the finer grades of temperature, called cool and warm."

Head and Sherren state that in complete division of a mixed nerve, as the median or ulnar, the area it supplies does not become uniformly insensitive. Whereas previous observers have stated that sensation is diminished over the full area usually assigned to the injured nerve and lost completely over a small portion only, they have shown that this diminution of sensation is in reality a total loss of sensibility to stimulation with cotton wool, to the compass test and to degrees of temperatures between 22° c. and 40° c. In this area are felt only the stimuli affecting the protopathic sensibility, such as the prick of a pin and temperature below 20° c. and above 40° c. The area rendered insensitive to light touch by division of the median or of the ulnar nerve varied little in extent. In sharp contrast to this slight variation stood the extreme difference in surface extent of the loss of sensation to pin prick which followed division of either of these nerves. "The consequence of both division and irritation of these nerves shows that as far as protopathic sensibility is concerned they overlap to an enormous extent."

From a study of 500 of our cases of peripheral nerve lesions observed soon after injury, it was seen that in many cases for the first two or three weeks only a very small area within the border of the part insensitive to cotton wool was sensitive to pin prick; that in a few a larger zone sensitive to pin prick appeared within fifteen days, and that the return of sensitiveness to pin prick in a larger zone, corresponding to the area which was later determined as nerve overlap, was found at times variable from thirty to 100 days.

It is essential to determine the cause of this relatively early return of prick pain. We must define that presence or return of

sensation which is due to partial lesions or the regeneration of a nerve and that which is due to the assumption of function of adjacent and overlapping nerves. It is to the misinterpretation of this early return of a prick pain that many early "recoveries" following nerve suture have been attributed.

The return of sensibility to prick pain that occurs before the return of sensibility to touch is due to the assumption of function by adjacent nerves. This return of prick pain always appears in similar areas in individual nerves and occupies the zone of nerve overlap. This zone may be determined by noting the residual sensation of a nerve.

The method of determining residual sensibility is based on the assumption that following section of a given nerve, the area of skin in the anatomic distribution of that nerve in which sensation remains is subserved by the intact adjoining nerves distributed to that area. For example, four nerves supply the palmar surface of the hand: the ulnar, median, musculocutaneous and radial. If two nerves, the ulnar and median, are severed that sensibility which remains is subserved by the musculocutaneous and radial. If, then, the borders of the musculocutaneous be determined, that which remains is radial (Figs. 35-38).

In employing this method certain precautions must be observed. For example, we cannot take the outer border of the analgesia on the dorsal surface of the hand in an ulnar section to be any part of the border of the overlap of the median unless we have observed the effect of a combined ulnar and radial nerve lesion so that the overlap of the latter nerve is not included. Similarly we cannot outline the border of the overlap of the median on to the radial unless we have a combined lesion of the ulnar and radial to indicate the distribution of the ulnar; or the overlap of the radial to the median on the palm unless we have observed the effects of a combined median and musculocutaneous lesion. Likewise we cannot outline the border of the overlap of the tibial into the area supplied by the peroneal unless we have had a combined lesion of the peroneal

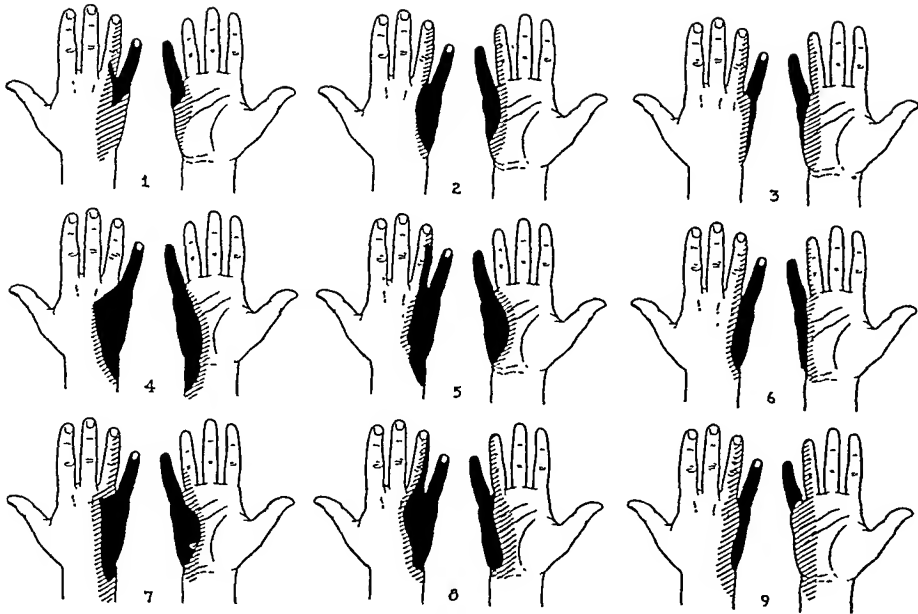


FIG. 35. Loss of sensation resulting from complete section of ulnar nerve. Algesic areas within accepted sensory supply of ulnar nerve are adjacent to intact median and radial nerves.

(1) Y. H. Gunshot wound, machine gun bullet. Upper third of forearm, July 18, 1918. Operated upon June 18, 1919. Examined July 21, 1919.

(2) J. K. Gunshot wound, high explosive. Above epicondyle, October 4, 1918. Operated upon March 12, 1919. Examination April 20, 1919.

(3) I. W. Gunshot wound, machine gun bullet. Upper third forearm, October 10, 1918. Operated upon September 13, 1919. Examined July 18, 1919.

(4) W. S. Gunshot wound, high explosive. Middle third forearm, September 27, 1918. Operated upon March 24, 1919. Examined April 20, 1919.

(5) T. H. Gunshot wound, high explosive. Middle third arm, October 28, 1918. Operated upon April 1, 1919. Examined April 23, 1919.

(6) J. M. Gunshot wound, high explosive. Middle third forearm, September 16, 1918. Operated upon September 17, 1919. Examined September 1, 1919.

(7) C. R. Gunshot wound, high explosive. Upper third forearm, October 11, 1918. Operated upon March 25, 1919. Examined June 1, 1919.

(8) C. N. Gunshot wound, high explosive. Upper third arm, October 17, 1918. Operated upon April 5, 1919. Examined May 10, 1919.

(9) W. P. Gunshot wound, high explosive. Middle third forearm, September 27, 1918. Operated upon September 6, 1919. Examined September 1, 1919.

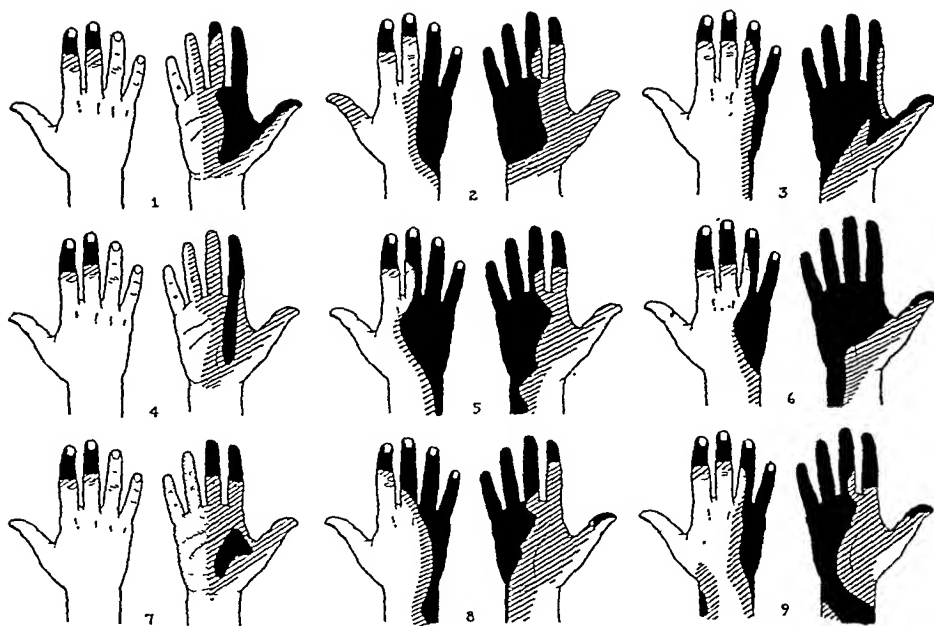


FIG. 36. Sensory loss following complete section of median nerve, 1, 4, and 7; median and ulnar nerves combined, 2 and 3; ulnar, median and medial cutaneous nerves combined, 5, 6 and 8; median, ulnar, musculocutaneous and medial cutaneous nerves combined, 9. Diagram 7 shows in addition to section of median nerve, slight hypesthesia over ulnar distribution due to a minor lesion of ulnar nerve. Diagram 9 represents the sensibility remaining in the hand after all the nerves with the exception of the radial, which supply sensation to the hand, have been severed. It follows that the radial nerve overlaps on to the palm to a large degree.

(1) V. A. Gunshot wound, high explosive. Lower third arm, Sept. 28, 1918. Operated upon May 21, 1919. Examined May 5, 1919.

(2) B. W. Gunshot wound, high explosive. Upper third forearm, Oct. 11, 1919. Operated upon April 18, 1919. Examined Apr. 18, 1919.

(3) G. P. Gunshot wound, machine gun bullet. Lower third arm, Oct. 31, 1928. Operated upon May 29, 1919. Examined May 17, 1919.

(4) R. A. Gunshot wound, high explosive. Right elbow, Aug. 4, 1918. Operated upon, May 5, 1919. Examined May 31, 1919.

(5) G. P. Gunshot wound, high explosive. Middle third arm, Oct. 4, 1918. Operated upon, April 5, 1919. Examined April 1, 1919.

(6) V. Q. Gunshot wound, high explosive. Middle third arm, Nov. 10, 1918. Operated upon, April 19, 1919. Examined, May 29, 1919.

(7) T. P. Gunshot wound, high explosive. Upper third forearm, Nov. 1, 1918. Operated upon May 27, 1919. Examined May 2, 1919.

(8) A. B. Gunshot wound, high explosive. Upper third arm, July 6, 1918. Operated upon May 6, 1919. Examined May 30, 1919.

(9) W. R. Gunshot wound, high explosive. Lower third arm, July 15, 1918. Operated upon June 29, 1919. Examined June 23, 1919.

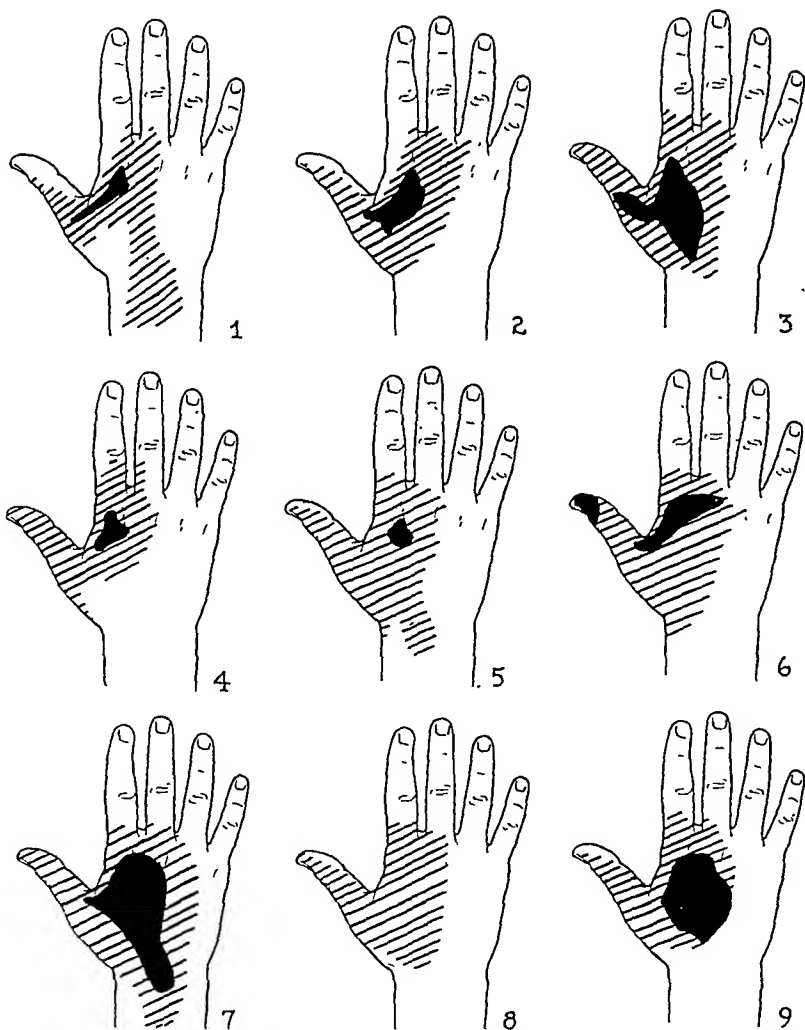


FIG. 37. Sensory loss which results from complete section of radial nerve. Diagram 8 illustrates that no analgesia may result.

(1) M. S. Gunshot wound, high explosive. Middle third arm, November 10, 1918. Operated upon May 21, 1919. Examined May 5, 1919.

(2) P. J. Gunshot wound, high explosive. Upper third arm, September 28, 1918. Operated upon May 16, 1919. Examined May 13, 1919.

(3) H. J. Gunshot wound, high explosive. Lower third arm, October 20, 1918. Operated upon June 3, 1919. Examined May 23, 1919.

(4) B. J. Gunshot wound, high explosive. Middle third arm, October 8, 1918. Operated upon March 22, 1919. Examined April 28, 1919.

(5) G. W. Gunshot wound, high explosive. Middle third arm, October 31, 1918. Operated upon March 17, 1919. Examined April 28, 1919.

(6) D. G. Gunshot wound, machine gun bullet. Upper third arm, October 26, 1918. Operated upon April 15, 1919. Examined May 18, 1919.

(7) W. L. Gunshot wound, high explosive. Upper third arm, October 31, 1918. Operated upon May 26, 1919. Examined May 1, 1919.

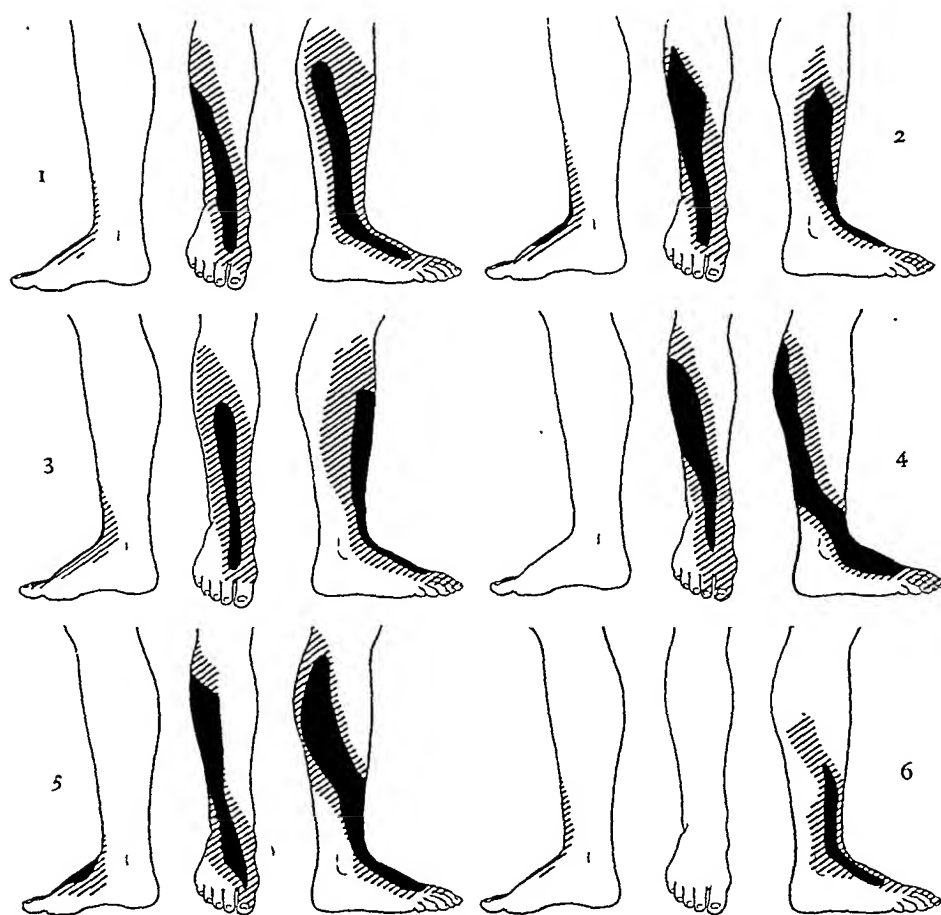


FIG. 38. Sensory loss resulting from complete section of peroneal nerve. Algesic areas within accepted sensory distribution of nerve are found adjacent to areas supplied by intact tibial and internal saphenous nerves.

(1) H. E. Gunshot wound, high explosive. Upper third leg, November 4, 1918. Operated upon May 8, 1919. Examined April 11, 1919.

(2) K. G. Gunshot wound, machine gun bullet. Upper third leg, October 14, 1918. Operated upon May 26, 1919. Examined June 30, 1919.

(3) S. F. Gunshot wound, machine gun bullet. Lower third thigh, August 17, 1918. Operated upon May 5, 1919. Examined April 28, 1919.

(4) K. J. Gunshot wound, high explosive. Knee, October 14, 1918. Operated upon May 5, 1919. Examined April 28, 1919.

(5) N. M. Gunshot wound, machine gun bullet. Upper third leg, June 24, 1918. Operated upon April 24, 1919. Examined June 15, 1919.

(6) S. W. Gunshot wound, machine gun bullet. Middle third thigh, October 3, 1918. Operated upon June 3, 1919. Examined July 29, 1919.

FIG. 37 (Continued):

(8) E. F. Gunshot wound, high explosive. Upper third arm, November 10, 1918. Operated upon May 8, 1919. Examined June 17, 1919.

(9) C. F. Gunshot wound, high explosive. Upper third arm, November 7, 1918. Operated upon April 22, 1919. Examined May 6, 1919.

with the internal saphenous. The necessity for these combinations reduces the number of cases available for conclusions to a very few. Owing to the lack of clinical material with certain

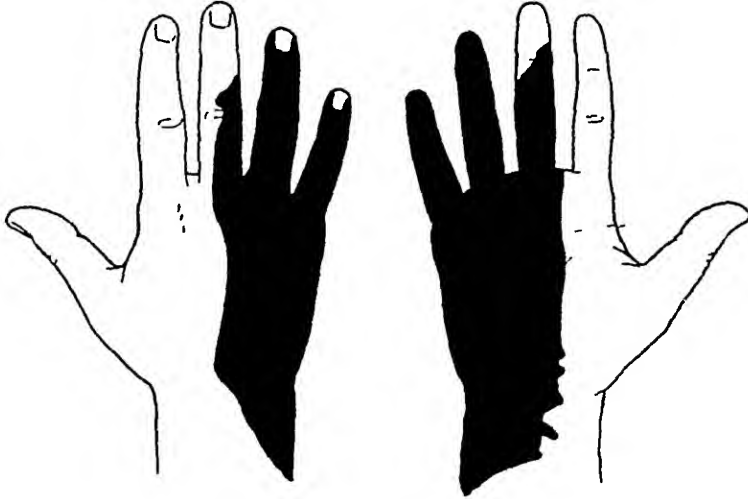


FIG. 39. Residual sensibility to pin prick in ulnar nerve lesion.

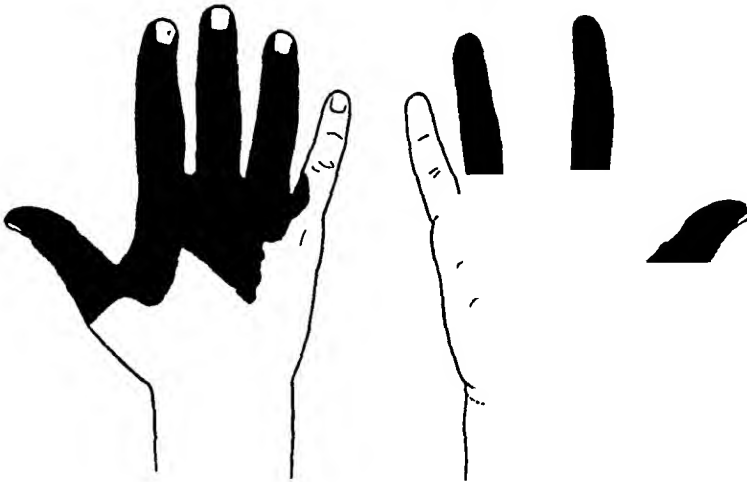


FIG. 40. Residual sensibility to pin prick in median nerve lesion.

combinations of nerve injuries, we have been unable to determine all the overlap areas of some of the nerves investigated. It is hardly necessary to state that the cases studied must have had the nerves recently resected or must have been examined

prior to an operation which revealed the ends of the nerve separated (Figs. 39-45).

In illustrating the areas of overlap, the space between the

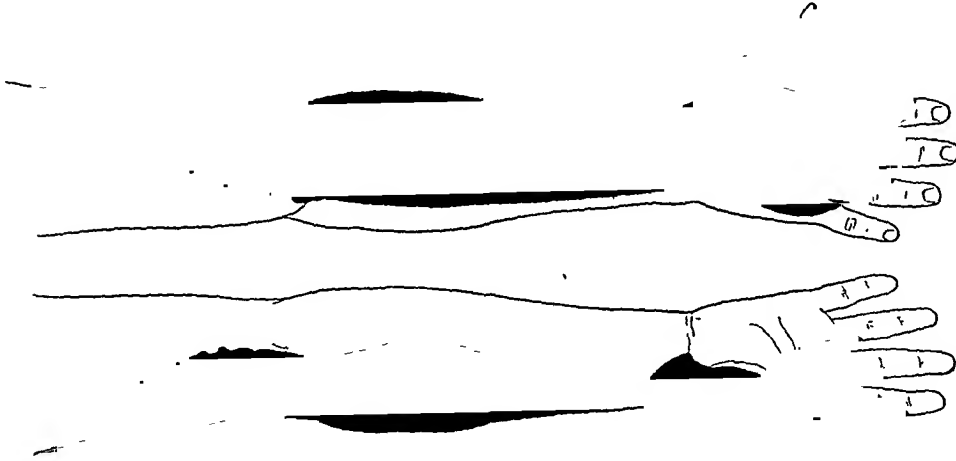


FIG. 41. Residual sensibility to pin prick in radial nerve lesions.

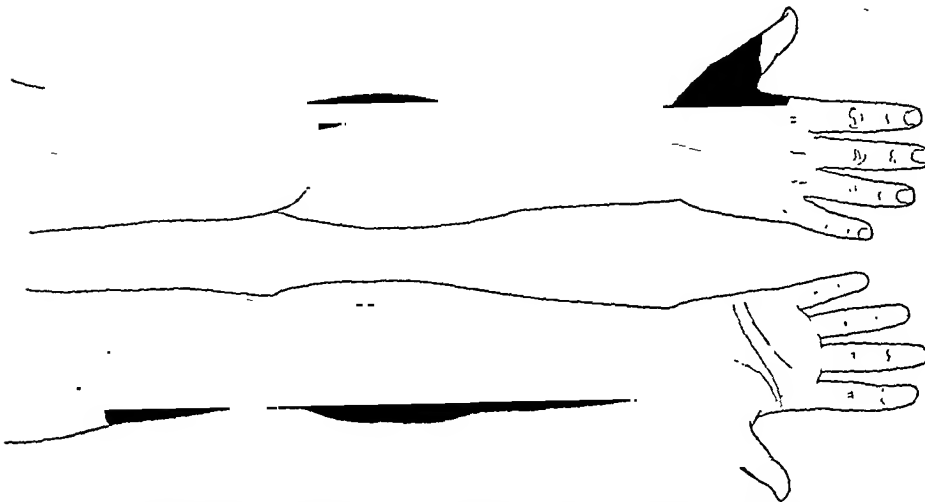


FIG. 42. Residual sensibility to pin prick in musculocutaneous nerve lesion.

borders of the overlapping to the adjacent nerves has been blocked out with black. The black area, therefore, added to the anatomic distribution of the nerve represents the total supply to pain of the various nerves studied. The areas of overlap to

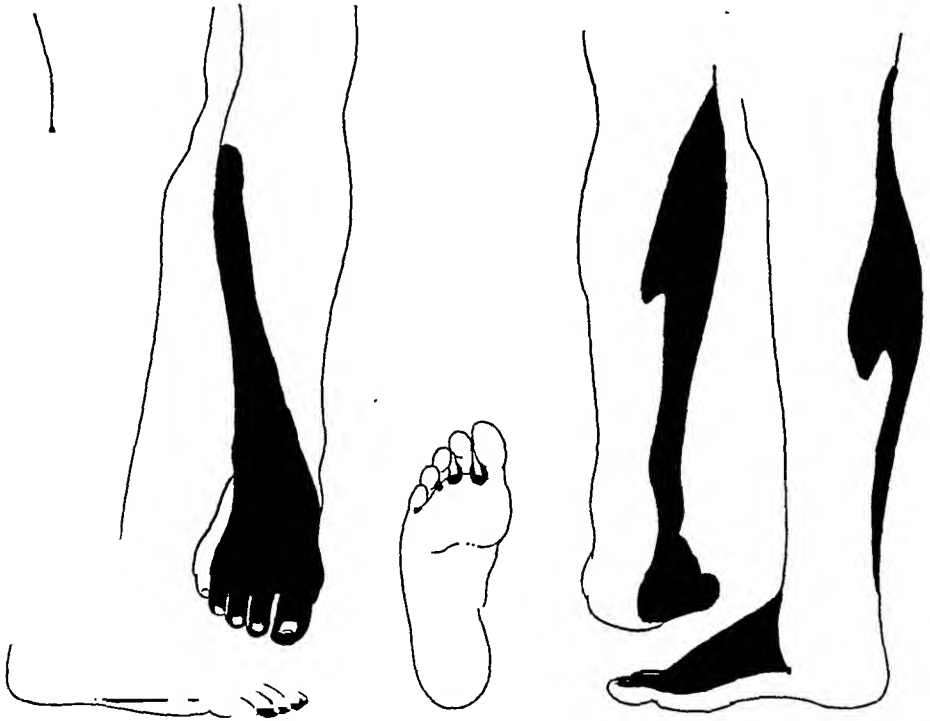


FIG. 43. Residual sensibility to pin prick in peroneal nerve lesion.

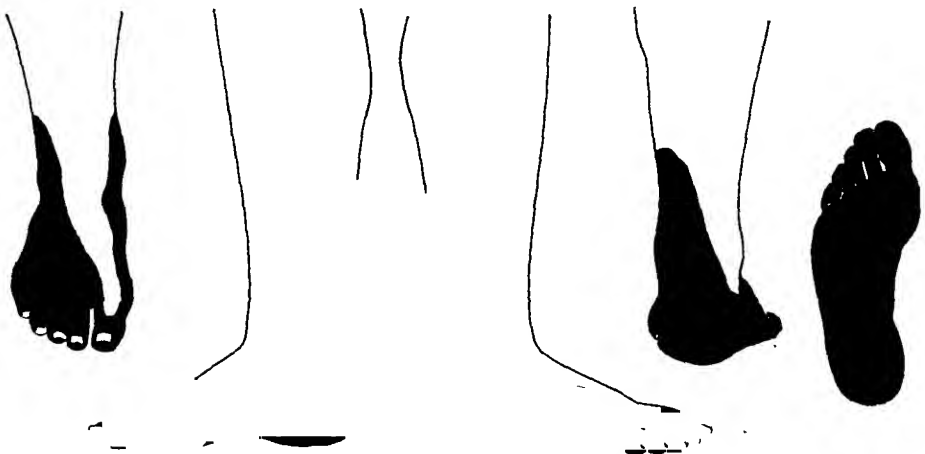


FIG. 44. Residual sensibility to pin prick in tibial nerve lesion.

[[420]]

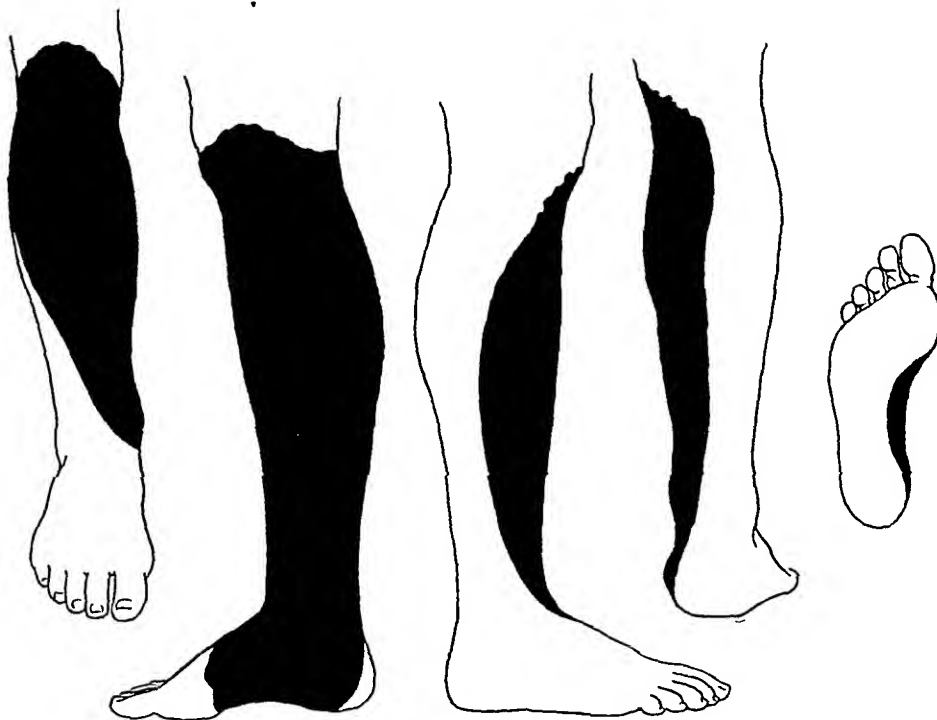


FIG. 45. Residual sensibility to pin prick in internal saphenous nerve lesion.

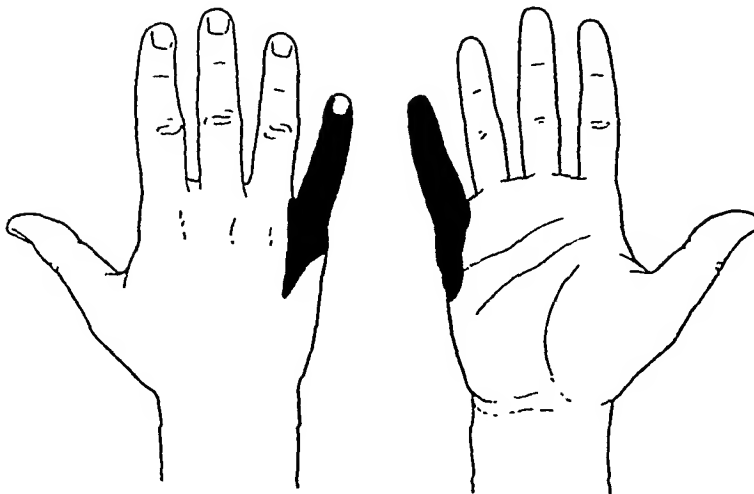


FIG. 46. Isolated sensory supply of ulnar nerve.

[[421]]

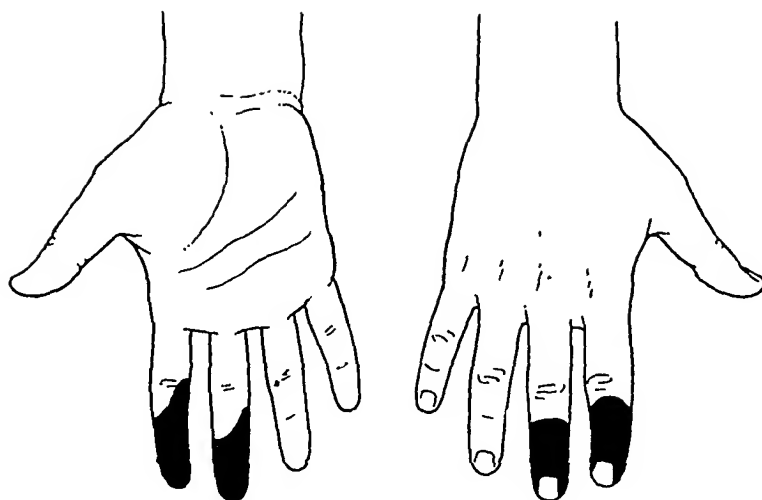


FIG. 47. Isolated sensory supply of median nerve.

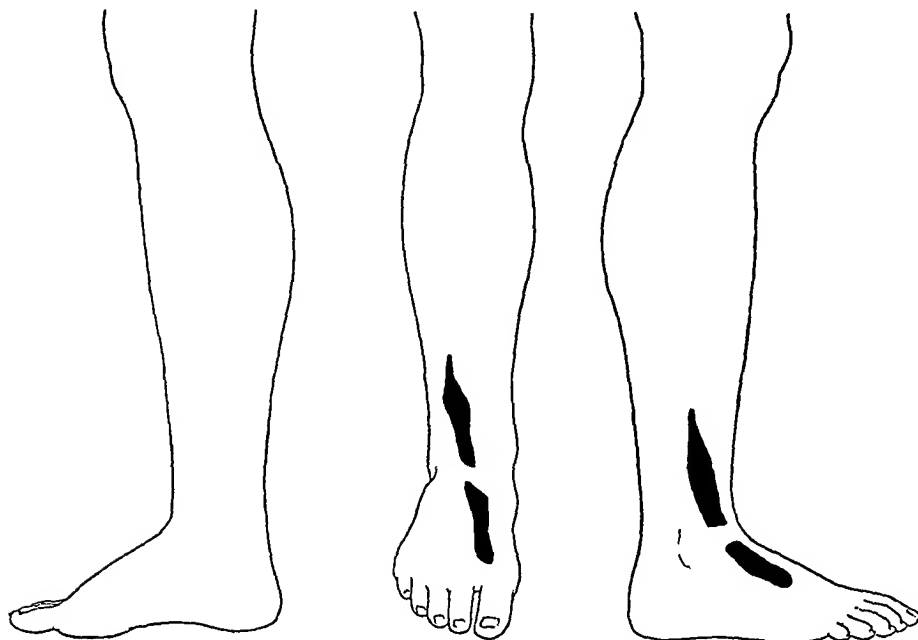


FIG. 48. Isolated sensory supply of peroneal nerve.

[[422]]

pain of the various nerves may be understood better by viewing the illustrations than by reading a description (Figs. 46-49).

If, therefore, the presence of return of sensation of pain in



FIG. 49. Isolated sensory supply of sciatic nerve.

the area of overlap cannot be interpreted as a sign of an incomplete lesion or recovery, it is necessary to outline the isolated supply to pain of each nerve. To delineate the area exclusively supplied with pain sense by a given nerve, one of two conditions must be present. First, the presence of pain sense having been demonstrated within the area of a nerve's supposed anatomical supply, that nerve must be found at operation to be divided and the ends separated. Second, the nerve having been seen to be divided, presence of pain sense is demonstrated in its distribution within the length of time given for the return of protopathic sensibility (Head, Rivers and Sherren, forty-three days).

The relatively few cases in our material does not make it profitable to attempt to outline the exclusive-supply of peripheral nerves to both epicritic and protopathic sensibilities. Suffice it to say that our results upon investigations of the epicritic sense in the hand are in general accord with Stopford. The areas of isolated supply to pain are shown in Figures

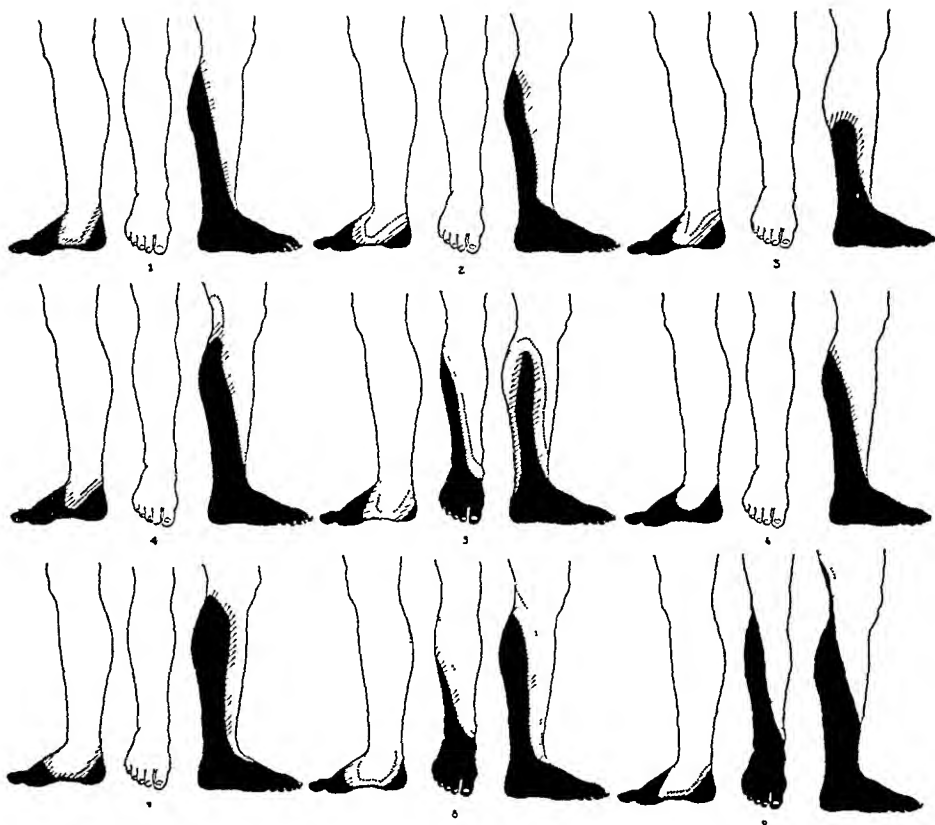


FIG. 50. Sensory changes which result from simultaneous section of more than one peripheral nerve in lower extremity (tibial and peroneal). No algesic zone can be found between areas supplied by these two nerves.

(1) L. J. Gunshot wound, high explosive. Middle third thigh, September 22, 1918. Operated upon March 19, 1919. Examined May 6, 1919.

(2) S. H. Gunshot wound, high explosive. Lower third thigh, October 4, 1918. Operated upon July 8, 1919. Examined May 5, 1919.

(3) W. P. Gunshot wound, machine gun bullet. Middle third thigh, July 31, 1918. Operated upon May 19, 1919. Examined May 3, 1919.

(4) D. C. Gunshot wound, machine gun bullet. Middle third thigh, October 1, 1918. Operated upon April 1, 1919. Examined May 20, 1919.

(5) H. C. Gunshot wound, high explosive. Lower third thigh, July 19, 1918. Operated upon January 27, 1919. Examined June 13, 1919.

(6) L. G. Gunshot wound, high explosive. Middle third thigh, October 10, 1918. Operated upon May 16, 1919. Examined July 10, 1919.

(7) L. H. Gunshot wound, high explosive. Middle third thigh, October 9, 1918. Operated upon April 7, 1919. Examined May 17, 1919.

(8) L. H. Gunshot wound, high explosive. Upper third thigh, October 9, 1918. Operated upon April 7, 1919. Examined July 7, 1919.

(9) H. S. Gunshot wound, high explosive. Right buttock, July 18, 1918. Operated upon July 8, 1919. Examined May 17, 1919.

46-49 and are described more fully under the description of the special nerves.

Inasmuch as the preceding illustrations represent the smallest area of exclusive supply of various nerves for pain, it is necessary to define to what extent they may be used in formulating our ideas relative to nerve overlap. In some instances such small areas may be present only when we are dealing with the group of 25 per cent of cases which show an unusual distribution of sensory nerves. These areas are used, therefore, only in establishing a certain limit beyond which it is not permitted to go in interpreting return of sensation to pain as a sign of nerve regeneration.

It is necessary to allude briefly to the proof that the early presence or return of sensation to pain upon the borders of the anatomic distribution of a nerve is due to nerve overlap and not to regeneration or partial loss of function. If the shrinkage of the area insensitive to pin prick, responsible for the increase in size of the intermediate zone, be a sign of nerve regeneration and not a result of overlap, it should occur whether or not the adjacent nerves are intact. This is not the case, however. Isolated lesions of the peroneal nerve may show only a small area of analgesia, but when the tibial as well as the peroneal is severed there is never any shrinkage of analgesia or reappearance of sensibility to prick pain in the zone where the supply of the peroneal meets that of the tibial (Fig. 50). Although in isolated lesions of the ulnar nerve sensibility to pain is frequently seen on the ulnar half of the ring finger, this is never observed when a median nerve is divided at the same time (Fig. 51). When the ulnar, radial and median nerves are divided, a year may follow their division and no shrinkage of analgesia be found on the palmar or dorsal surface of the hand, except on the proximal portion of the analgesia where the musculo-cutaneous and the antibrachii posterior areas adjoin the analgesic area (Fig. 52). When a radial lesion is combined with a median, analgesia is always present on the radial part of the palm. When a median lesion or a radial lesion alone is present,

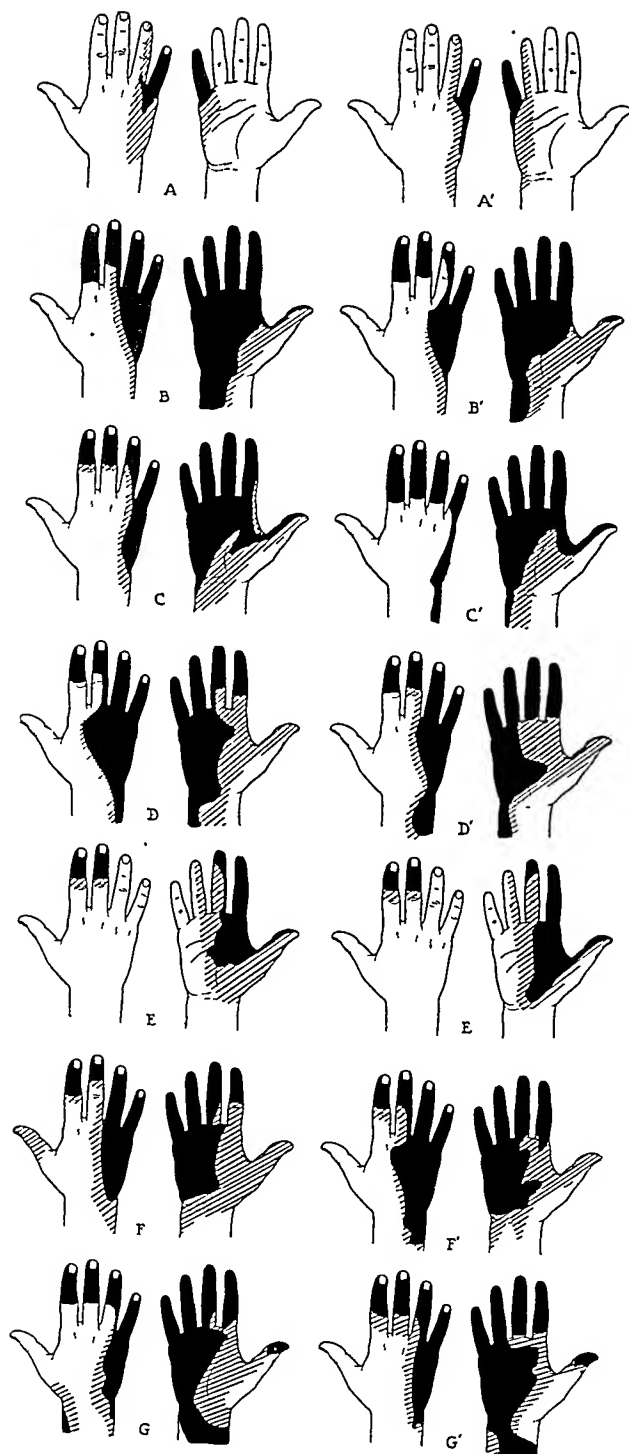


FIG. 51.
[426]

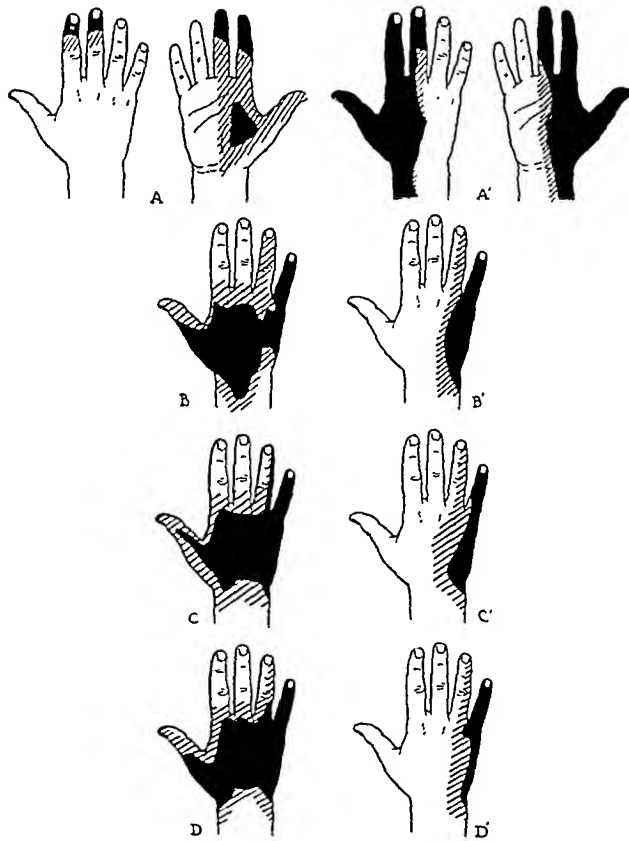


FIG. 52. A, Sensory loss resulting from a complete section of the median nerve; A', when the superficial radial nerve was subsequently severed, the preexisting sensibility of the radial side of the palm disappeared. B, C, D, Sensory loss on dorsum of hand resulting from complete section of ulnar nerve. B', C', D', when the superficial radial nerve was severed subsequently to be used as a transplant, the algesic area found within the sensory distribution of the ulnar nerve disappeared.

FIG. 51. Sensory changes before and after resection and suture of various peripheral nerves. A, before, A', after resection and suture of ulnar nerve; B, C, D, before, B', C', D', after resection and suture of ulnar and median nerves in cases with additional lesions of median cutaneous; E, before, E', after resection and suture of ulnar and median nerves; G, before, G', after resection and suture of ulnar, median and musculocutaneous nerves.

- A, Examined July 21, 1919; operated upon June 8, 1919. A', July 21, 1919.
- B, Examined April 5, 1919; operated upon April 4, 1919. B', May 29, 1919.
- C, Examined May 17, 1919; operated upon May 29, 1919. C', July 8, 1919.
- D, Examined April 1, 1919; operated upon April 5, 1919. D', May 29, 1919.
- E, Examined May 5, 1919; operated upon May 21, 1919. E', June 1, 1919.
- F, Examined April 18, 1919; operated upon April 18, 1919. F', May 30, 1919.
- G, Examined June 23, 1919; operated upon June 29, 1919. G', July 11, 1919.

this part of the palm is usually sensitive to pin prick. It can be definitely stated also that when nerves supplying adjoining areas are severed, sensation to pain is at no time present in the

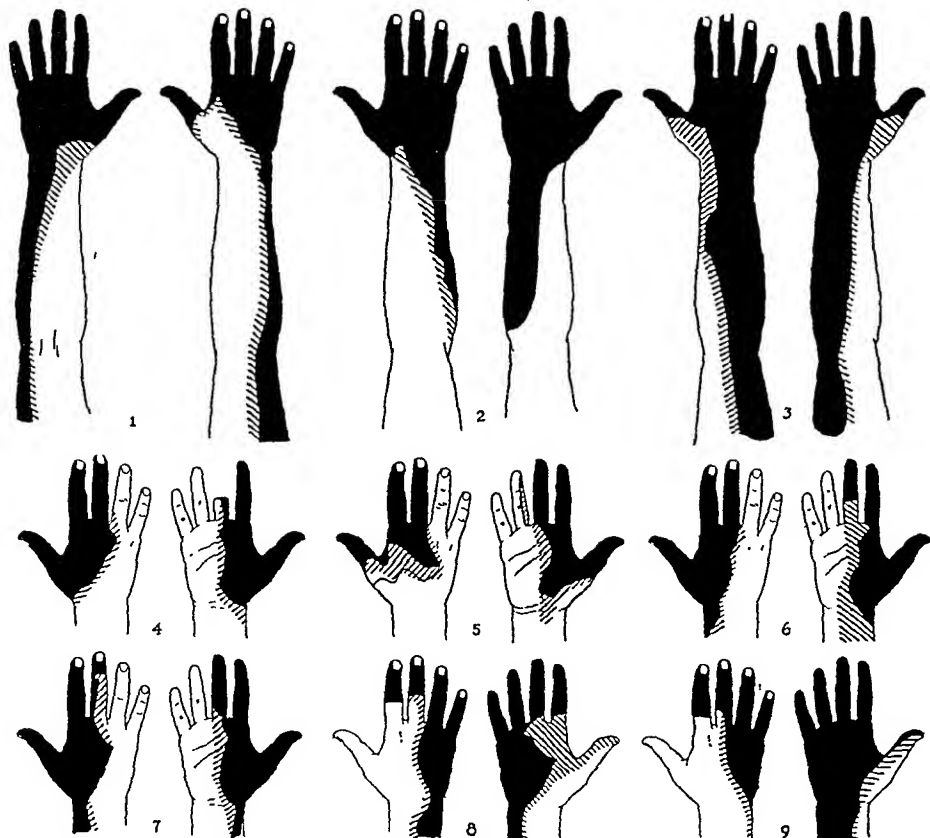


FIG. 53. Sensory loss resulting from simultaneous section of more than one nerve.

(1) Ulnar, median, radial, medial cutaneous of arm and forearm.

(2) Ulnar, median, radial and medial cutaneous of forearm.

(3) Ulnar, median, radial, medial cutaneous of arm and forearm.

(4, 5, 6, and 7) Radial and median.

(8, 9) Ulnar and median.

In no instance is there return of pain sensibility upon borders between sensory distribution of several severed nerves.

border areas, where it is uniformly observed when either nerve is divided alone (Fig. 53).

Inasmuch as a large number of our cases have had resections and sutures performed at least three months prior to the

last examination, it may be stated likewise that no sensation to pain returned in such areas in the time given for the beginning of regeneration of protopathic sensibility. If certain areas of skin become sensitive to pain or are found sensitive to pain following the section of a given nerve and if this condition is due to nerve regeneration, then section of the adjacent nerve should have no effect upon the appearance of this sensibility. However, it was constantly found that when return to sensibility to pain or presence of sensibility to pain was found in the area of overlap of an adjacent nerve, analgesia resulted if this nerve was severed. In a case in which a partial ulnar lesion was combined with a complete section of the median nerve prick pain was preserved in the radial portion of the palm and index finger. When the superficial radial nerve was resected at operation for use as a cable transplant, this part of the palm became analgesic. This proves that the sensation present in the radial portion of the palm and index finger was subserved by the radial nerve. Likewise in cases of complete section of the ulnar nerve in which the superficial radial nerve was severed and used as a cable transplant, the pre-existing sensibility to pain on the radial border of the sensory supply of the ulnar nerve disappeared, proving that this sensibility was subserved by the radial nerve.

Resection and suture of nerves does not produce an analgesia in an area of overlap into which the sensation of pain has returned. The conditions necessary to study profitably the effect of resection and suture of nerves on return of sensibility to pain are: first, that the nerve ends be separated and, second, that the examination subsequent to operation be made within the period of time ascribed to the return of protopathic sense as the result of regeneration. The areas which are sensitive to pin prick in the lesions examined and the sensory changes following operation need only be illustrated. It is sufficient to state that the following nerves were studied; ulnar, examined 42 days after operation; ulnar and median, 45, 36, 40, 46 and 14

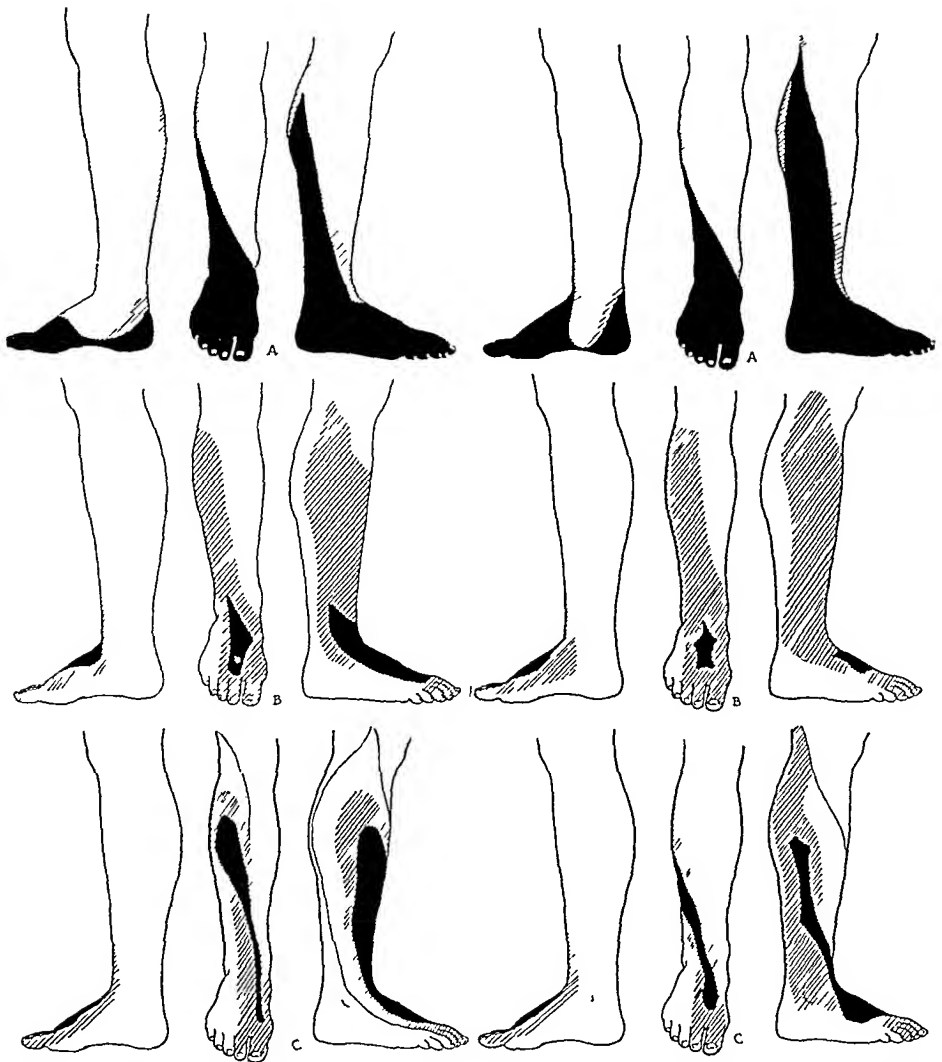


FIG 54. Sensory changes before and after resection of sciatic nerve (A, E) and peroneal nerve (B, C, D, F).

A, Examined June 16, 1919, operated upon July 21, 1919. A', July 29, 1919.

B, Examined May 30, 1919, operated upon July 7, 1919. B', July 29, 1919.

C, Examined May 15, 1919; operated upon June 4, 1919. C', July 22, 1919

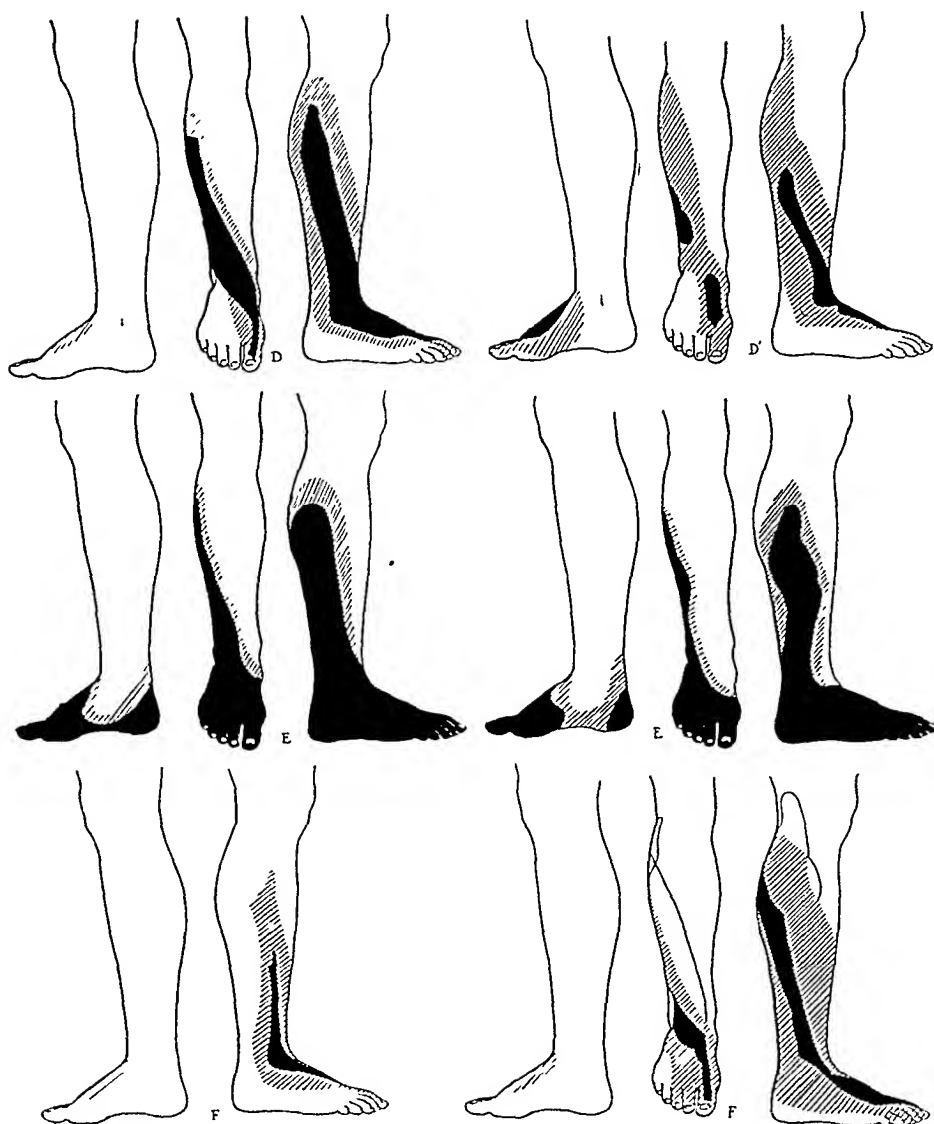


FIG. 54. (Cont.)

D, Examined May 30, 1919; operated upon July 9, 1919. D', August 9, 1919.
 E, Examined June 29, 1919; operated upon June 23, 1919. E', August 29, 1919.
 F, Examined June 5, 1919; operated upon May 1, 1919. F', May 31, 1919.

days after operation; peroneal, 48, 36, 20 and 26 days after operation; and sciatic, 50 and 36 days after operation (Fig. 54).

Head and Sherren state that: "Sometimes it is necessary to divide an injured nerve, after sensibility to prick has already begun to return to the hand, that more perfect union may be obtained. Wherever such an operation has been performed, the parts that had begun to recover sensibility became again insensitive to prick, a proof that the recovery must have been due to union, however imperfect, of the divided nerves." In cases which show a return of sensibility to pain as the result of actual regeneration, subsequent resection would be expected to produce analgesia. Similarly, the existence of sensibility to pin prick in a partially severed nerve would be destroyed if that nerve were resected. The whole area of the anatomic sensory supply of a nerve must be rendered analgesic following resection before it can be stated that no part of the return of sensation was due to overlap. In all of our cases, dissociated return of pain sense occurred within the area of nerve overlap and remained intact following resection and suture. Nowhere have we found an illustration of dissociated return of pain sense except in such an area of overlap.

The preceding observations show that the dissociated return of sensibility of cutaneous pain occurs only in areas of possible overlap. When several nerves serving adjacent areas are severed simultaneously, sensibility to cutaneous pain is not present after injury, nor does it return before tactile sensibility in the borders between these areas where it is commonly present when one nerve is severed alone. When a region in the area of sensory distribution of a severed nerve is sensitive to cutaneous pain, and this region is adjacent to another nerve area, if this latter nerve be severed complete analgesia results in the previously sensitive region.

When sensibility to prick pain is present or returns in the area of possible overlap on to the sensory distribution of the severed nerve, subsequent resection and suture of this nerve does not change the general extent of this sensitive area,

although the borders may at times be slightly enlarged or diminished. That is, the pain sense which returned or was present before the operation was not due to partial regeneration.

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No. 3

THE PROSTATE AT THE CROSSROAD*

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NEW YORK

IN the light of recent developments in the field of obstructing lesions of the prostate (aside from acute pathology) it is interesting to note the numerous attempts that have been made to correct these conditions without resort to the now generally accepted method of enucleation by means of open operation.

Many years ago, Bottini, later followed by Chetwood, essayed the method of galvanocautery incision of the neck of the bladder, the approach to which in most instances was through a perineal exposure, with results so unsatisfactory that further efforts in this direction were practically abandoned.

Among the first really satisfactory methods of endo-urethral removal of bars or prostatic fibroses, was that of the punch apparatus of Young, which when limited strictly to these conditions and in the hands of experts, still functions as an effective procedure.

Later Caulk of St. Louis converted this instrument into a cautery punch and still later the writer of this paper had constructed a telescopic visualized punch with a pistol grip closure. A number of investigators produced other methods of this basic development by Young. Caulk with characteristic enthusiasm and rare courage, elevated the eyebrows of his more conservative colleagues, including the writer, with the statement that he was operating 80 per cent of his prostatic cases

with the cautery punch. Incidentally he is substantiating his claim, not only through his own work but through that of others, notably Engel of Crile's Clinic, a brilliant young associate of Lower and a former pupil of the writer, who has performed with the Caulk method 30 odd operations during the past year with highly satisfactory immediate results.

In this country the first reported cases wherein prostatic encroachment on the urethra and vesical outlet treated endoscopically with the high frequency current were exhibited by the writer nineteen years ago before the Urological Section of the New York Academy of Medicine. One was a case of lobulated prostatic enlargement with 14 ounces of residual urine, in which the patient remained well with a perfectly functioning bladder during a period of ten years' observation. The second, a patient with median lobe hypertrophy, with 4 ounces residual urine, returned with the same symptoms, after a period of five years.

The outcome of subsequent attempts in the general application of this method were such as to lead to the conclusion that with the instrumental and electrical equipment of that day, it was not equal to the exacting demands of this highly technical procedure.

Stern of New York later developed what he called a resectoscope. He believed that in this instrument he had a revolutionary

* Read before the Bellevue Hospital Alumni Association, New York City, October 7, 1931.

method for partial excision of the prostate, at least that portion of the gland that hindered the natural emptying of the

deep sense of appreciation for its personal impress, it has seemed to this writer that these various methods, while highly con-

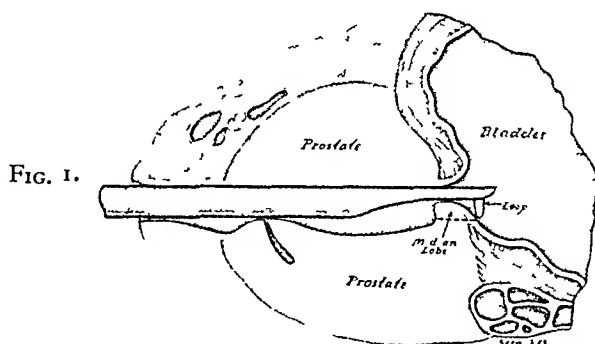


FIG. 1.

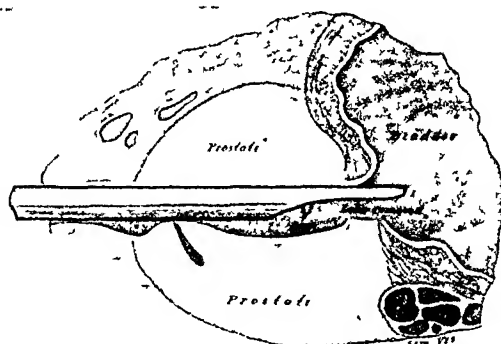


FIG. 2.

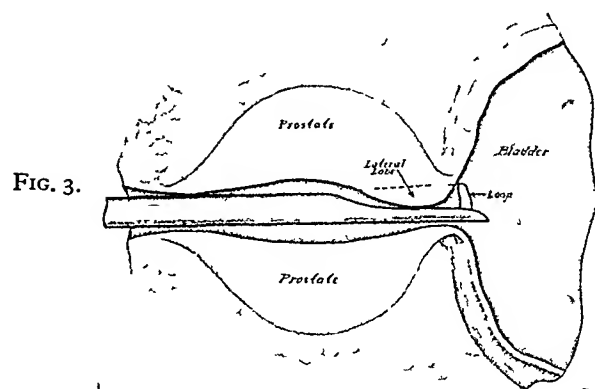


FIG. 3.

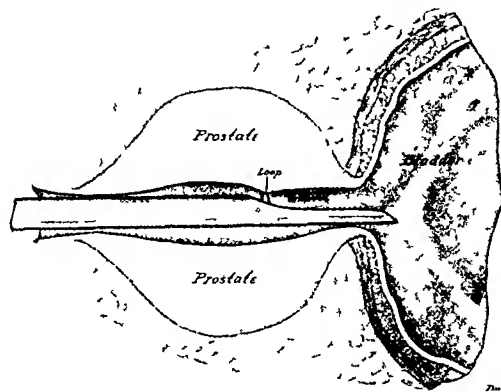


FIG. 4.

FIGS. 1 to 4.

bladder. If he did not accomplish quite that much, at least he had assembled the essential elements thereof. It is to be regretted that he did not carry the method through to its logical conclusion.

Devis of North Carolina, a painstaking student of the subject, took up this work and to his great credit has demonstrated that the removal of prostatic encroachments per urethra, by means of an electrical cutting current adapted to an urethroscope, is a wholly feasible operation.

Luis of Paris also has performed a somewhat similar operation which he calls "fourrage de la prostate."

Foley of St. Paul has demonstrated an ingenious method of instrumental endourethral prostatectomy.

Without in any way wishing to derogate from this constructive work, and with a

constructive and in the hands of these men effective, leave much to be desired before a general application of endoscopic prostatic resection can come into universal use.

The ideal requirements for this operation are as follows:

1. The most precise visualization of the prostatic urethra.

2. The greatest possible flexibility of manipulation *under vision*, of the electric cutting loop.

3. Ample electrical power to excise the obstructing prostate under water with a coincidental minimum of hemorrhage and of *tissue coagulation*.

4. Interchangeability and ease of manipulation of electrodes, in the closure of bleeding points.

5. The completion of the operation including the introduction of a No. 24 French whistle tip indwelling catheter,

with but one introduction of the instrument, the sheath being withdrawn after the catheter has been passed through it.

This has been rendered possible by the remarkable achievement of Mr. Frederick Wappler of New York City, whose research

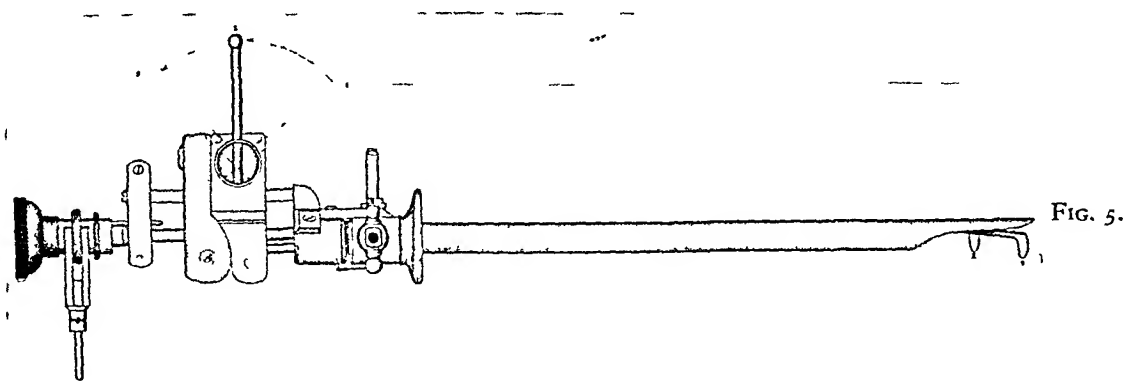


FIG. 5.

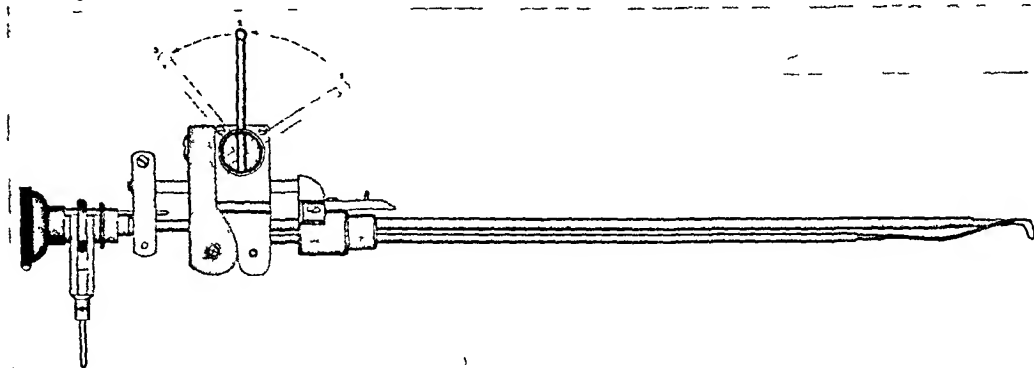


FIG. 6.

FIG. 5.—McCarthy visualized prostate electrode assembled.

FIG. 6 —Shows cutting and optical construction.

6. Rapid epithelialization with a minimum of cicatrization.

on this question (at the solicitation of the writer) has culminated in the construction

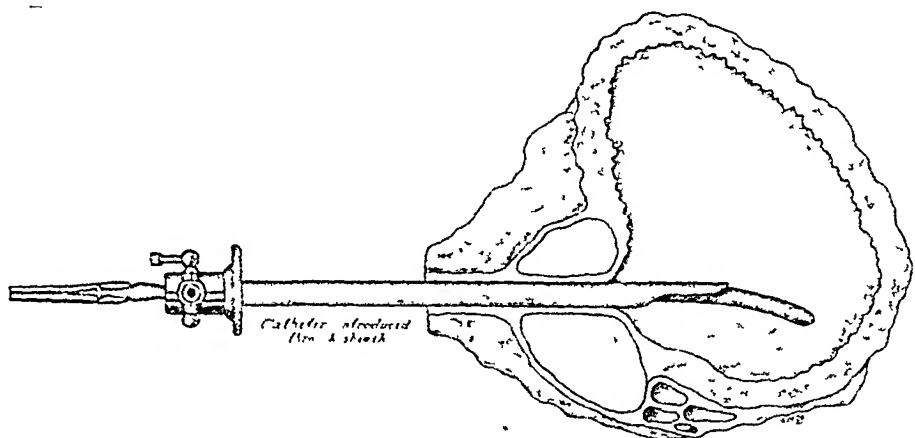


FIG. 7.

For the first time in medicine the equipment herewith described adequately meets these exacting demands.

of an electric arc cutting machine, that insofar as the writer is aware, has not been hitherto attainable. It supplies a degree

of cutting power and desirable current characteristics for the excision of tissue under water, or other aqueous media,

early diagnosis of prostatic carcinoma.

A word of caution should be interjected here to admonish the casual instrumenteur,

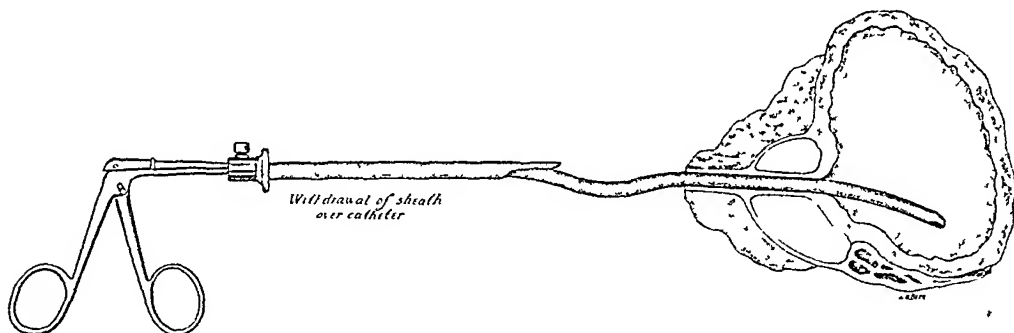


FIG. 8.

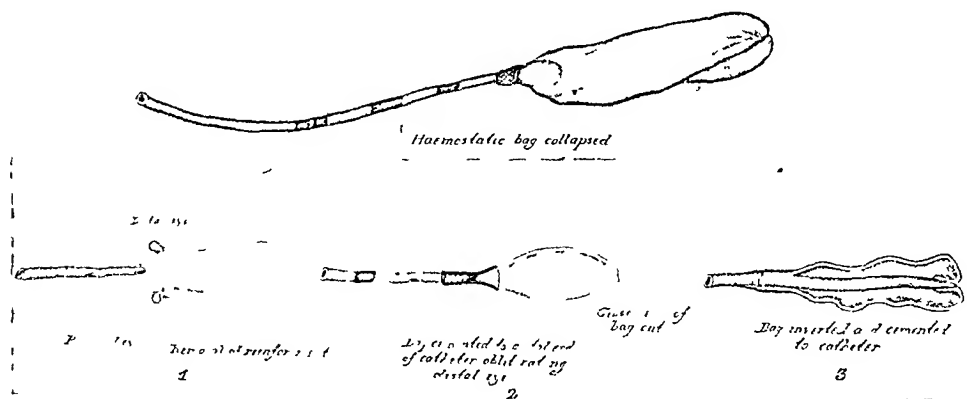


FIG. 9.

greatly in excess of any possible clinical requirement.

The well-known pan-endoscopic system of vision of this author, with a non-conducting bakelite sheath together with the accompanying cutting loop electrodes, constitutes the armamentarium.

With this equipment in the hands of an experienced urologic clinician, who has been trained in the use of the pan-endoscope, wherever it is possible to introduce the instrument, it is demonstrably feasible adequately to treat all cases of prostatic fibrosis—the majority of cases of prostatic hypertrophies—to afford symptomatic relief in the presence of scirrhus types of carcinoma of the prostate, without resort to open operation. It may also serve in certain cases as an ideal measure in the

or the occasional surgeon, that this is not a simple procedure. It is in fact a highly technical one, to be essayed only by those expert with instruments and qualified to cope with the occasional difficulties that in a large series of cases are inevitable.

Nor should it be performed promiscuously, or under circumstances preventing personal supervision of the postoperative care. In fact the only mortality encountered by the writer since the inauguration of this study occurred under the latter conditions.

In the cases treated by this method to date, there has been a notable absence of worry on the part of the surgeon, patient and family, which have been an all too frequent concomitant of open prostatectomy. The brevity of hospital domicile, two to ten days, and in this respect we have perhaps

been ultraconservative, has, especially in these days, decided economic advantages.

Following the hospital domicile there is a brief period of increased frequency of micturition, which soon disappears. In but 2 of our cases was there any noticeable degree of post-hospital discomfort, which was in no measure comparable to the obvious and prolonged disability following open prostatectomy.

In this series we have treated types of prostatic obstruction from the *now* simple fibrosis, to the complete retention of middle and lateral lobe enlargement, with symptomatic relief and the ability completely to empty the bladder.

Now if these assertions be true, and we are prepared to substantiate them, the case types previously described should constitute but a minor field of application, for this advanced technique. If it is possible by this method, as is here asserted, to remould the prostatic urethra at will, to remove with complete facility early prostatic encroachments or fibroses, it would seem the method should experience its greatest usefulness in the first field of medicine, Prophylaxis.

CONCLUSION

It should be the duty of the internist and general practitioner to more closely scrutinize and evaluate the symptoms of individuals in the prostatic range, of nocturia, hesitancy at the onset, feeble and prolonged micturitional act, terminal dribbling, etc. In all cases residual urine should routinely be estimated.

For the very good reason that, if the judgment of the writer is not strabismic, it is quite within the domain of the probable to prevent these prostatic obstructive manifestations, with their attendant pathologic sequelae, their accompanying morbidity, mental and physical.

Obviously, the prostate in more senses than one, is "At the Crossroad."

Since the reading of the foregoing paper, much has been gained in the way of additional clinical experience, not only on the part of the writer and his immediate associates, but also with a number of

collaborators throughout the country.

There have also been added to the technical equipment certain refinements,

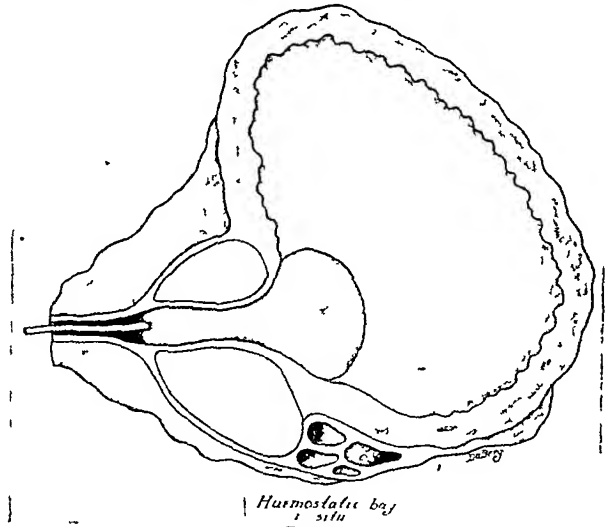


FIG. 10.

as well as preventive measures for the control of oozing in the unusual type of case. Pertinent questions have also been asked, which will be herein answered.

The acid test of time generally acts as a brake on early enthusiasm. Here it has had the opposite effect on my immediate associates, my collaborators and myself. This is proved by our joint experience in several hundred cases. It has been stated that if a departmental head can sell a new procedure to his immediate associates, he can with equanimity face the outside world. For it is they who "follow through" on his cases, have a precise knowledge of postoperative complications, and poor end results cannot be glossed over.

It is our general conviction that the procedure is a revolutionary one, which will find a large and important place in the prevention and management of benign prostatic disease, and in the alleviation of the malignant.

The following questions have been asked:

How may the occasional active oozing be controlled? Bleeding points are visualized and coagulated under vision. The return flow should be free from color on the completion of the operation. Should there be persistent oozing difficult to control and involving excessive coagulation which

is not to be practiced, a balloon bag has been provided, which can be made in the clinic. The bag consists of a very thin finger cot of good quality, attached to a calibrated whistle tip ureteral catheter. The open end of the cot is freed of its reinforcement and by means of rubber cement, fixed to the distal end of the catheter. This fixation includes the end of the catheter and the distal eye, leaving the proximal eye free. Fine black silk is wound about the cemented end of the cot. A small opening is then made in the closed end of the cot, which is then inverted over the catheter, about three-fourths as far as it will go. It is important that the bag should be relaxed and not on the stretch; else when filled, it will bend the filling catheter. The end of the cot is then cemented to the shaft of the catheter below the proximal eye, the cemented portion is then reinforced with a winding of black silk and rendered smooth with cement substance. Acknowledgment is here made to my associate Dr. Joseph A. Hyams, for the final consummation of this valuable addition to our armamentarium. Thus constructed the operator has a simple and effective means of control in a manner similar to the Ballenger or Hagner bag. When well lubricated with liquid albolin it may be introduced through the sheath, the latter withdrawn, the bag inflated with 40-50 c.c. of water and drawn gently and with moderate firmness, into the prostatic urethra, about one third the pressure employed with the ordinary prostatic bag being used.

The bag may be maintained in position for one or two hours, after which it is deflated and withdrawn, and a No. 24 French whistle tip catheter introduced for drainage. The bag may be reintroduced at will by first passing the pan-endoscope.

How much tissue can be removed? As much as desired. The prostatic urethra may be remoulded at will.

It is well for urologists, even the most competent, to at first confine their work to the floor of the prostatic urethra. They will be surprised at the functional results

noted. This work has exploded the previous misconception of the important role played in urinary obstruction by the lateral lobes.

What about the permanency of the procedure? The experiences of Caulk and Davis, who have concentrated their efforts on this field along different technical lines for a much longer period than the writer, would seem to indicate its relative permanency. Cysto-endoscopic study of our earliest cases reveals plastic, smooth urethrae, and a maintenance of symptomatic relief.

The crux of the matter may be summed up in the statement that medical men who know most about it elect this procedure for themselves in preference to the more radical prostatectomy. Inasmuch as it is attended with minimal risk, with but brief hospitalization, a repetition of the revision should not militate against it.

What about repeats? In our Clinic at the Post-Graduate Hospital there have been, all told, about half a dozen. This may be explained on the technical ground that we proceeded most cautiously until there was sufficient clinical background, as a basis for the further extension of the step.

What preliminary preparation should these patients have? The same as for prostatectomy. Especial caution must here be exercised in the toilet of the bladder and sterilization of the urine.

What is the immediate postoperative care? Frequent irrigation with sterile, normal salt solution through the catheter and the constant maintenance of drainage. Otherwise one must intervene and correct the condition.

When should the indwelling catheter be withdrawn? After the drainage has been constantly clear for two days. Generally on the third or fourth day.

Finally, because of the unprecedented interest in this procedure there is already at hand a large and rapidly accumulating amount of clinical data. This justifies the claims made in this paper, and will, at an early date, serve to determine its limitations as well as its precise field of application.

EXPERIMENTAL PRODUCTION OF SEVERAL VARIETIES OF

BONE SARCOMA

BY INTRAMEDULLARY INJECTIONS OF THE VIRUS OF THE FILTERABLE FOWL
ENDOTHELIOMA TUMOR*

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WITH FOREWORD BY

WILLIAM, B. COLEY, M.D.

NEW YORK

FOREWORD

THE first transplantable chicken tumor was discovered by Fujinami of Japan in 1909, and was a spindle cell sarcoma. This tumor had many remarkable features. It survived the destructive action of sunlight, x-ray and radium, and when dried, withstood heat up to 75°C. for thirty minutes.

Peyton Rous in 1911 revealed the fact that there was a certain disease in fowls closely resembling malignant tumors in man, and that although he was unable to isolate the causative agent, he could reproduce this tumor at will in Plymouth Rock fowls by injections of a cell-free filtrate. This was regarded as a most important and highly significant discovery because of the probable or possible analogy between these sarcomas in chickens and human malignant tumors. Whether these fowl tumors were caused by an organism so small that it could readily pass through a porcelain filter, or whether they were due to a so-called filterable virus or chemical agent, was a question that remained unanswered. Regardless of which theory was accepted, the fact remained that it was possible to produce in chickens, by an extrinsic agent, tumors that were believed to be true sarcomas, and which developed metastases precisely like the metastases in human cancer, causing death the same way.

In July 1925, Gye brought out his noteworthy contribution to experimental work upon the Rous sarcoma agent, and for a time it seemed that a definite step forward

had been made in the solution of the hitherto insoluble problem of the etiology of malignant tumors. Gye started out with the hypothesis that malignant tumors were due to one or more microorganisms or viruses, which produced a malignant tumor only when the soil was made favorable by the breaking-down of the natural resistance of the body cells by some specific factor, known or unknown. In his own words:

These researches have led me to look upon cancer—using the term in its widest sense—as a specific disease caused by a virus (or group of viruses). Under experimental conditions the virus alone is ineffective; a second specific factor, obtained from tumour extracts, ruptures the cell defences and enables the virus to infect. Under natural conditions continued “irritation” of tissues sets up a state under which infection can occur.

Gye believed he had proved the truth of his theory by treating the Rous sarcoma agent with chloroform until it had apparently become inert and could no longer cause tumors to develop in Plymouth Rock fowl; then later, by adding some other substances of varied nature, he was able to produce tumors. He called this other material which reactivated the inert virus, a *specific factor*.

Unfortunately no one else was able to repeat Gye's experiments. The conclusion reached by most critics was, that the Rous sarcoma agent had not been entirely destroyed by the chloroform and that the subsequent production of tumors, after adding the so-called *specific factor*, was due

* Gibney Memorial Fellowship Thesis, Laboratory of the Hospital for Ruptured and Crippled, New York. Submitted for publication December 29, 1931.

to the still active Rous sarcoma virus itself.

The failure of Gye to establish the proof of his theory in no way weakened the

In a paper on "Some Clinical Evidence in Favor of the Extrinsic Origin of Cancer"¹ I stated:

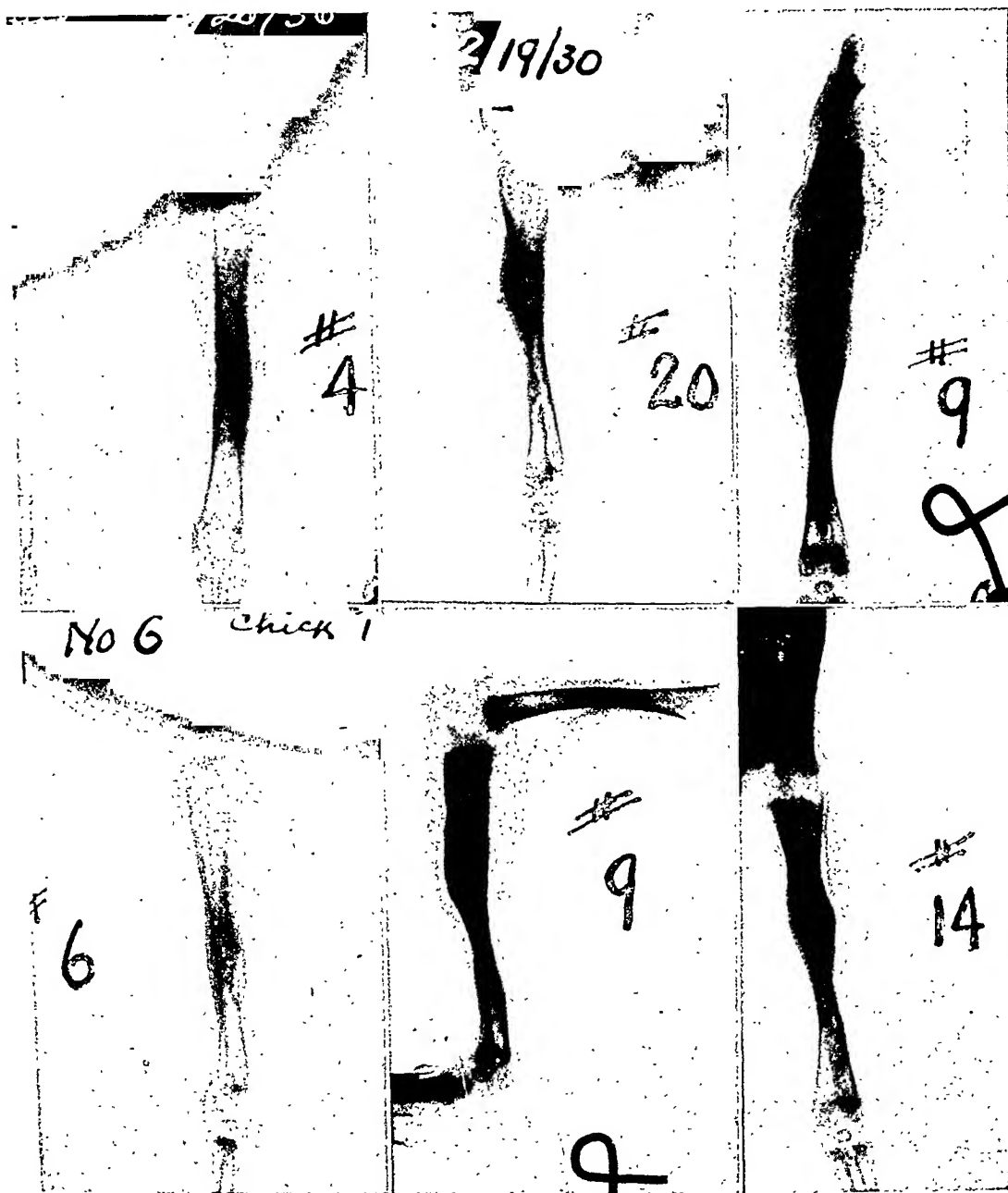


FIG. 1. Group 1. Typical x-ray appearance of bone involvement in this group. Chicks No. 4, 20, 9, 6, 14.

broader theory which I have held for many years: that malignant tumors are due to an unknown microorganism or microorganisms, widely distributed, to which most individuals are exposed, and which require a favorable soil for development.

"If we assume the extrinsic cause of cancer, then it is easy to understand why the number of cancer cases varies in different geographical areas. It is easy to

¹Read before The American College of Surgeons, October, 1924: *Surg. Gynec. Obst.*, 40: 353, 1925.

explain why some races have little or no cancer and others living in the same localities but with entirely different habits

had the members of its staff devote their entire time to the study of infections, abandoning for the time their research



FIG. 2. Group 1. High power photomicrograph of bone tumor of group 1. Note cellular make-up of tumor, rounded or polyhedral cells, highly chromatic nuclei, and occasional giant cell. Chick No. 3.

of living and diet have many cases of cancer. If we assume an extrinsic cause of the disease, it is easy to understand that this organism may be very widely distributed over the world, that everybody is exposed to it, and yet that it requires a soil peculiarly fitted for it to obtain a firm hold in man and produce a cancer. I do not believe that the question of *favorable soil* has ever received due recognition in discussions on the etiology of cancer. During the Great War, the Imperial Cancer Research Society of Great Britain

work in the field of cancer. A most important paper on "The Mechanism of Bacterial Infections, with Special Reference to Gas Gangrene" was brought out in the Sixth Scientific Report of the Imperial Cancer Research Fund, 1919, by two of these workers, Bullock and Cramer. In it they state that very many wounds, especially those received on the Western Front, were injected with the bacillus of Welch, but only a very small percentage of those infected wounds developed gas gangrene. The same thing was found to be true in

animals; of some hundred mice and guinea-pigs injected with the bacteria of tetanus, only a very small percentage contracted

but rather that they effect a local breaking down of the defensive mechanism against the bacteria of gas gangrene and tetanus.

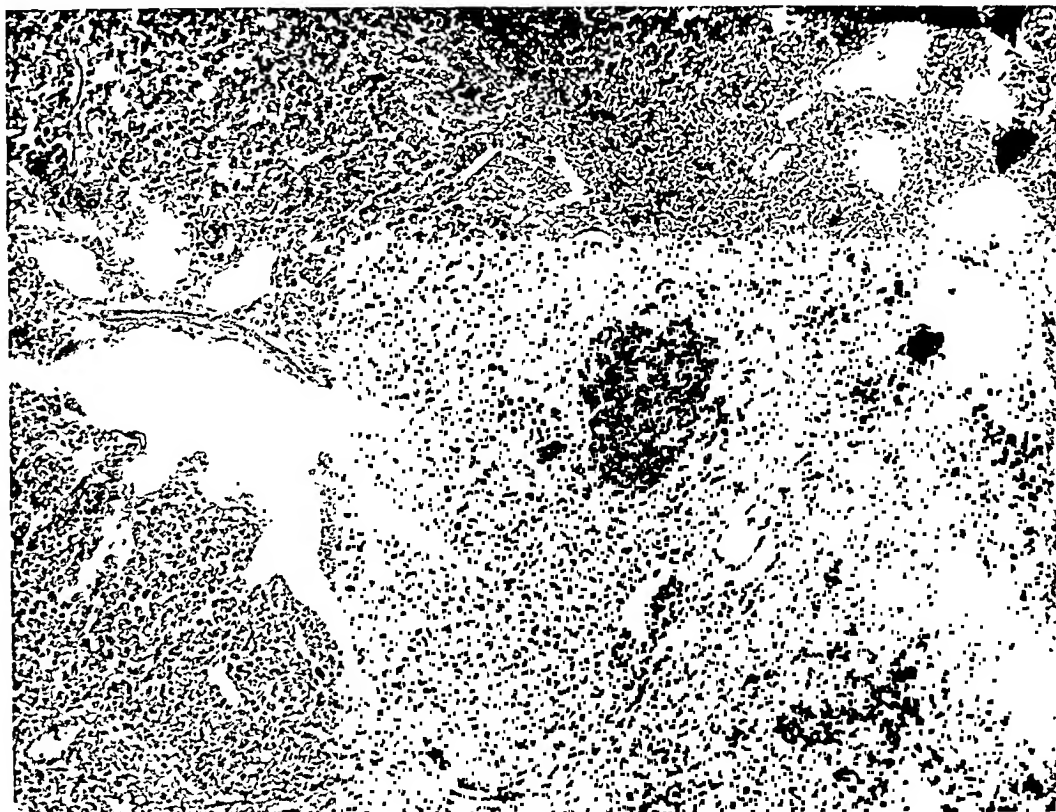


FIG. 3. Group 1. Tumor in lung associated with tumor in Figure 2. Note similarity of cellular elements. Chick No. 3.

the disease. It was found, however, that doses of 2.5 milligrams of calcium chloride, when injected subcutaneously into mice of 10-15 gram weight, together with a suspension of a virulent strain of *bacillus welchii* or *vibrio septique*, will produce a violent gas gangrene in every case. According to Bullock and Cramer: 'The normal animal disposes of the bacteria mainly by lysis and partly also by phagocytosis, and this defensive mechanism is so efficient as to render these bacteria non-pathogenic when injected by themselves. If a small dose of soluble ionisable calcium salt is injected together with the bacteria or their spores, the specific disease is elicited in a very virulent form.' In explaining this action, they do not believe that the calcium salts possess some power to increase the virulence of the organism;

This new phenomenon they characterize as 'kataphylaxis.' These experiments, I believe, have a very important bearing on the question of cancer, and go far toward explaining how it might happen that a great many people—perhaps the majority—could be exposed to a micro-parasitic agent caused by cancer and only a very small percentage become infected."

In an editorial on the Ninth Scientific Report of the Imperial Cancer Research Fund¹ it is stated:

The work of Gye was the first attempt to formulate a conception in which the development of malignancy in the filterable fowl tumors presented merely an exaggeration of the process underlying the development of malignancy in mammals. Although the experimental evidence he brought forward in support

¹ *Lancet*, Dec. 20, 1930.

of his views has not been accepted, his work has had the effect of establishing the fowl tumors as true malignant new growths.

Our investigations indicate very forcibly that we are confronted with a systemic infection characterized by long latency and exhibit-

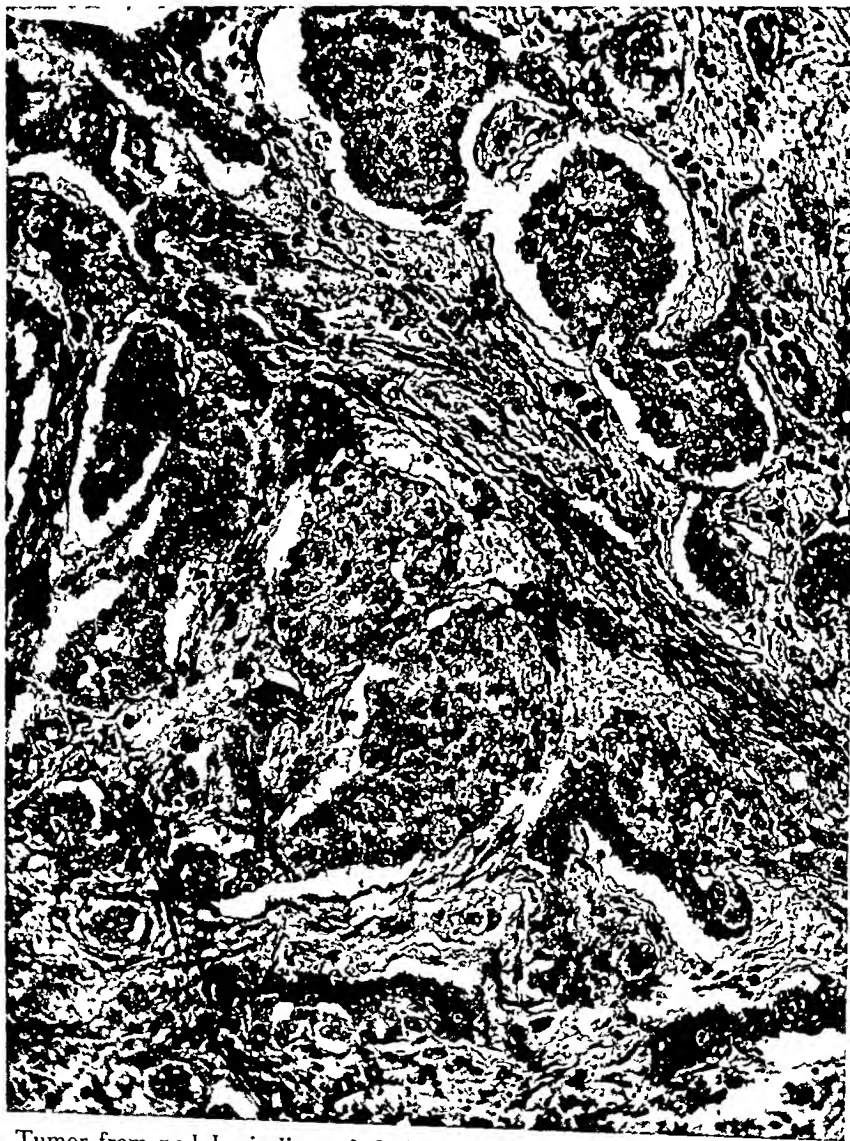


FIG. 4. Group 1. Tumor from nodules in liver of chick No. 9 of this group. Note epithelial structure of cellular element,¹ for the most part in broad branching tufts.

The recent and very important survey of cancer in Westmorland County, England, of which a preliminary report was published¹ furnishes new evidence. This survey covered a period of two years, and was made by Dr. Louis Sambon, already widely known for his cancer investigations in various countries in Europe as well as in the American tropics. To quote it briefly:

ing varied local manifestations, determined in type and site by the most diverse physical, chemical, mechanical, or animate irritants. Insidious invasion, long quiescence, complexity of secondary factors, muteness of symptoms, and protean nature of manifestations are the peculiar features which have baffled inquiry so persistently.

The parasitic, unobtrusively infective nature of the disease is attested by its peculiar distribution both in time and place . . .

Perhaps the most striking, the most interesting discovery our investigations have elicited

¹ *Brit. M. J.*, 2: 1062, Dec. 7, 1929.

is the great prevalence of all types of malignant and other neoplasms in animals. We have met with cancer in all kinds of wild and domestic

When Connor¹ published his experiments in the production of endothelioma in the tibia of young chickens, I became greatly



FIG. 5. Group 1. Silver stain preparation of same tumor as Figure 4. Note large amount of cellular, and small amount of fibrous elements.

animals, in pet animals, and in animals used as food. We might mention horse, cow, sheep, hog, cat, dog, hedge-hog, rabbit, vole, mouse, fowl, turkey, goose, owl, canary and toad."

In a recent paper on "Cancer Control"¹ I have dealt more fully with the whole question of the extrinsic origin of malignant tumors in man.

¹ Coley, W. B. Cancer control. *Am. J. Surg.*, 14: 605, Dec., 1931.

interested and suggested to Dr. Richard F. Berg, who had just received the Gibney Memorial Fellowship at the Hospital for Ruptured and Crippled, and who had elected to spend his year in the study of bone sarcoma under my direction, that it might be worth while to repeat and try to carry along still further, the experiments of Connor. Through the kindness of Dr.

¹ Connor, C. L. Experimental sarcoma of bone. *Arch. Surg.*, 19: No. 5, Nov., 1929.

W. E. Gye of London, I received some of the dried virus from the filterable fowl tumor (endothelioma) originally discovered

In this connection it is interesting to recall that Sir Charles Ballance of London at the meeting of the American Surgical

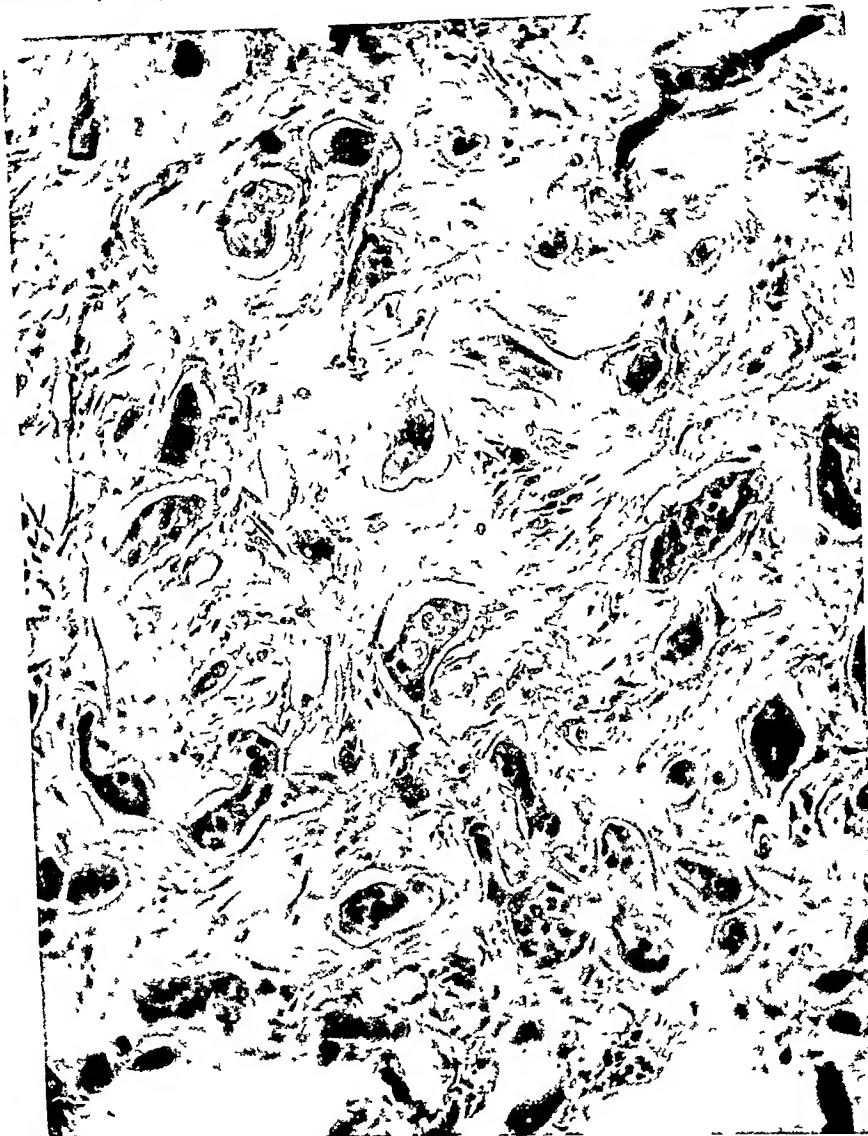


FIG. 6. Similarity of metastatic carcinoma in human (radius) to tumor seen in chick. Figure 4.

in 1927 in the laboratory of Dr. Murray of the Imperial Cancer Research Fund, and with this, the following experiments were conducted. Berg not only confirmed Connor's experiment showing the possibility of producing typical endothelial myeloma or Ewing's sarcoma in the tibia of Rhode Island Red chicks, but, by using the tumors of the second and third series for inoculation, he was able to produce five different histological types of tumors closely simulating the different types of malignant bone tumors in man, four sarcomatous tumors, one epithelial tumor.

Association just twenty-five years ago said that he not only firmly believed that malignant tumors were due to some form of microparasitic agent but he further believed that the same microorganism might, under different conditions, give rise to various histological types of tumors.

If there is an analogy between malignant tumors in animals and those in man, this experiment—the production of several different varieties of malignant tumors in animals—would show that it is not improbable that some similar extrinsic agent

might be able to produce the various types of malignant tumors in man. If there is no analogy between animal tumors and

workers have continued to search for this living agent believing it to be the real cause of malignant tumors. Inasmuch as it was

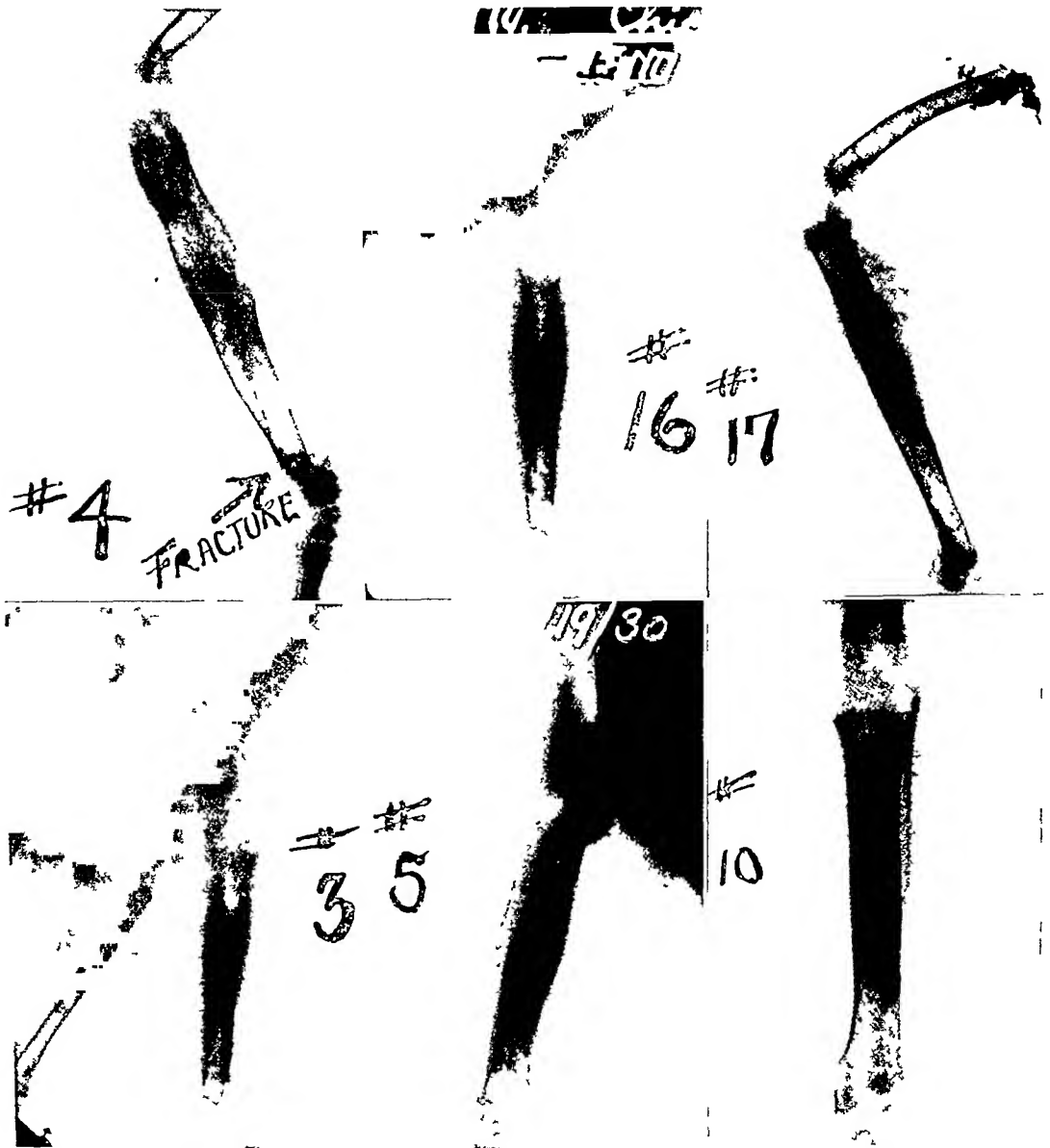


FIG. 7. Group 2. Typical x-ray appearance of bone involvement of the chicks in group 2. Chicks No. 4, 16, 3, 17, 5, 10.

human tumors then it would seem that a vast amount of money and labor on the part of research workers during the last thirty years has been spent in vain.

Although Rous, Gye, or other investigators have never been able to produce a pure culture or to isolate a living agent from the filterable fowl tumors, many

found impossible to obtain a culture by the use of ordinary media, it occurred to me that it might be worth while trying the special medium prepared by Glover,¹ upon which, alone, he has been able to grow his own organism obtained from

¹Glover, T. J. The bacteriology of cancer. *Canada Lancet & Practitioner*, 74: No. 3, 1930.

human cancer. Glover very kindly furnished us with some of his medium. After the first inoculation we obtained an

stage. Likewise, with the filtrate, it is possible to produce tumors in animals. During the last year (1931) experiments

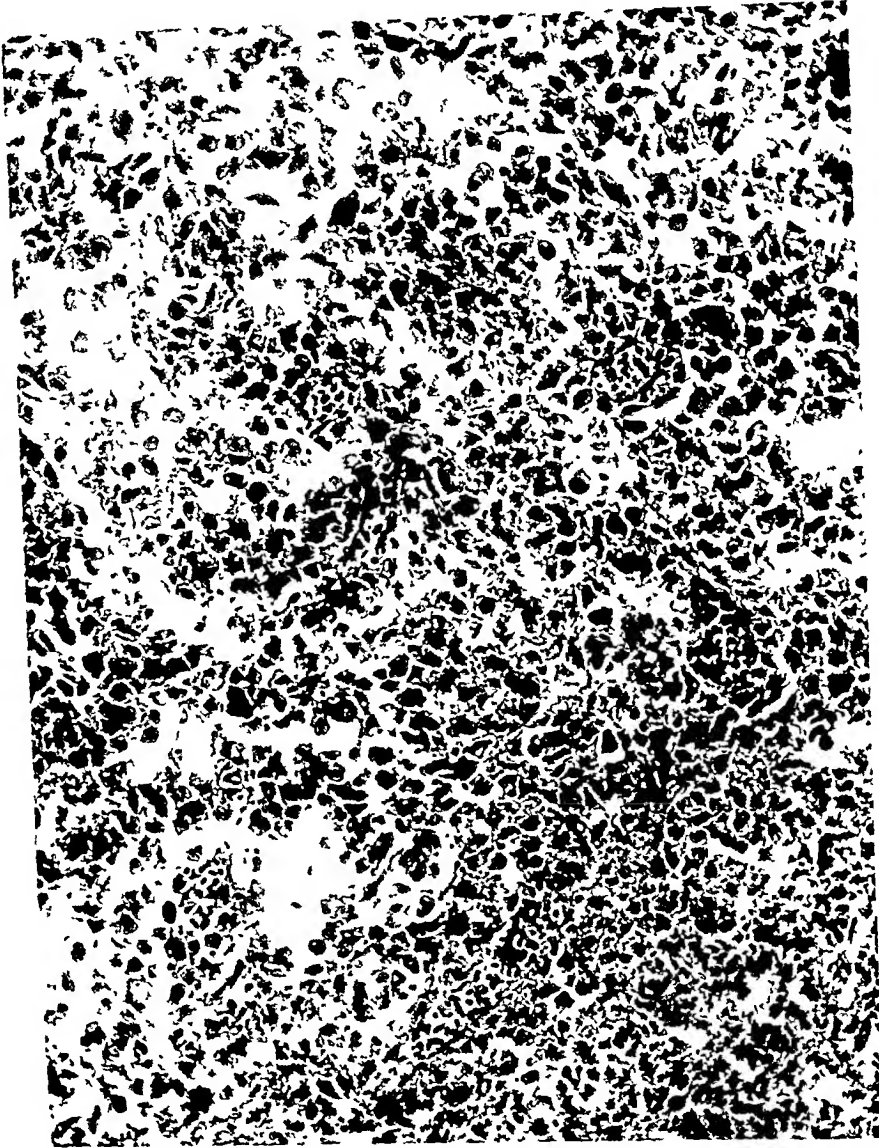


FIG. 8. Group 2. High power photomicrograph of typical tumor in group 2. Note similarity to that seen in typical tumor of group 1. Cells are for the most part of the endothelial type. Chick No. 4.

organism in pure culture from the tumors Berg had produced.

These tumors have been pronounced true malignant tumors by a number of experienced pathologists. We have compared the organism with the one found by Glover in human cancer, and believe it to be practically identical. Like Glover's, it is a pleomorphic organism, passing through the same stages of cyclic development, and, like the Glover organism, has a filterable

with this living organism have been carried on by Dr. John E. Sullivan (Dr. Berg's successor to the Gibney Memorial Fellowship of the Hospital for Ruptured and Crippled) and myself.¹ We have been

¹Owing to a lack of facilities at the Hospital for Ruptured and Crippled for animal experimentation on a large scale, our later experiments with the organism were for the most part carried out at the Murdock Research Laboratory, Bronx, New York. We are greatly indebted to Dr. Thomas J. Glover, the Director of the laboratory, for his generous help and cooperation, without which the work would not have been possible.

able to produce tumors in chickens, pigeons, rats, rabbits and guinea pigs, by inoculations of pure cultures of this organism. These tumors have the characteristic clinical features of malignant neoplasms in man, and their histological structure is likewise characteristic. Furthermore they have been pronounced true malignant tumors by a number of experienced pathologists. A further report of the work will be published in the near future.

THE EXPERIMENTAL PRODUCTION OF SEVERAL DIFFERENT VARIETIES OF BONE SARCOMA

RICHARD H. BERG

PROTOCOL

The chickens used in this work were incubator hatched Rhode Island Reds, varying in age from one to seven days at the time of inoculation. Chicks were all from the same strain and same hatchery. For the first experiment the material furnished through the kindness of Dr. W. E. Gye was prepared according to his directions. Thirty chicks were used in this group. The dose was 0.2 c.c. of the filtrate injected into the pectoral muscles on one side. For some reason, none of these chicks developed tumors, so accordingly another series of 25 chicks were inoculated with 0.5 c.c. of filtrate prepared from the remaining portion of the dried tumor tissue. The material had evidently lost its power to produce tumors or there must have been a flaw in the technique for none of the second series developed tumors either. A second vial of dried tumor tissue was then obtained from Dr. Gye and this proved to be very active, and the results of the three following groups are described below:

GROUP 1.

Preparation of Filtrate. The technique used in all the experiments was as follows.

Four grams of the dried tumor tissue together with a small amount of sterile silver sand were thoroughly mixed with distilled water by slowly adding the fluid until 100 c.c. had been used. This mixture was then transferred to centrifuge tubes and after a few minutes at slow speed the supernatant fluid was withdrawn and passed through a sterile Berkefeld candle; the resultant clear fluid was tested for its sterility. For convenience the fluid was transferred to 10 c.c. sterile vaccine ampules and sealed, ready for use.

Technique. Twenty-five chicks were inoculated, with careful asepsis, in two sites: 0.5 c.c. of the filtrate into the pectoral muscles and 0.2 c.c. into the medullary cavity of the tibia on the same side. This was done by forcing a needle through the knee joint downward into the medullary cavity.

Of this group:

- 21 chicks developed tumors in the breast
- 19 chicks in the tibia and breast
- 2 chicks in the breast alone
- 4 chicks with no tumors at all.

Most of the chicks died in from two to three weeks and the rest were killed and necropsies performed. The majority showed metastatic nodules in the lungs, liver and heart muscles, and one of the chicks of this group, No. 9, showed extremely numerous nodules in the liver which on pathological examination were considered to be of epithelial nature rather than connective tissue. Figures 4 and 5 show sections of this tumor. The bone lesions in this chick corresponded histologically to the others seen in the group (endothelial type). See Figure 1. This is a very interesting finding not easily explained and whether the tumors arose spontaneously and independently of the bone tumor in the tibia is a matter of conjecture. If it did arise as the result of the original injection, we would have to explain it on a transmutation basis. If we accept the latter explanation we must almost agree that the one causative agent in tumors is capable of producing a multiplicity of lesions, depend-



FIG. 9. Group 2. Section of bone tumor in chick No. 17, with compact arrangement of cells in marrow cavity, and lacunae. Bone shows destruction.



FIG. 10. Group 2. Gross specimen from bone tumor in chick No. 17. Note the marked bone destruction.

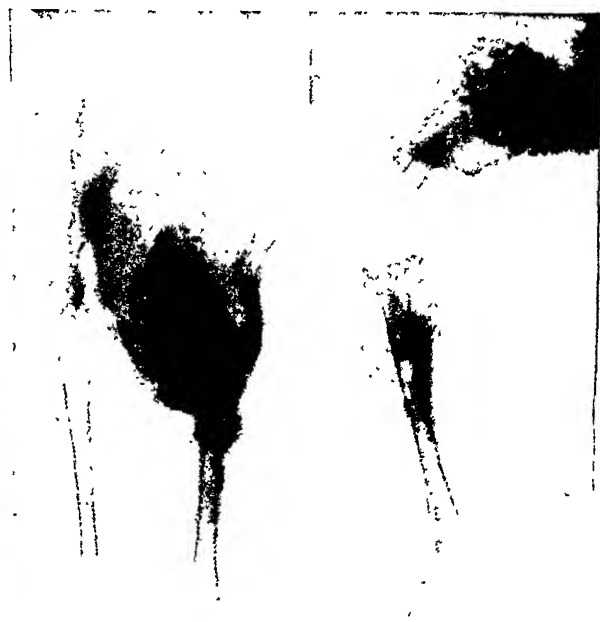


FIG. 11. Group 2. x-ray of tumor, with radiating spicules of new bone, and soft tissue involvement. A spontaneous tumor was also present in this chick in tarsal bone of same leg. Chick No. 6.

ing upon the site attacked. The other bone tumors were essentially similar from x-ray, gross and histological examination. Figure

this group were of the same strain as used in the first group, and were one week old. The same technique was used in preparing



FIG. 12. Group 2. Low power photomicrograph showing the radiating spicules of new bone and the thin remnants of the cortex in the center. Chick No. 6.

2 shows a characteristic microscopic view of the tumors developed in this group. It is also similar to the tumor seen in chick No. 9 which developed the strange liver nodules.

GROUP 2.

Twenty-five chicks were inoculated in this group with the filtrate obtained from the dried tumor tissue obtained from the breast tumors of group one. Chicks of

the filtrate as in the first group.

The tibias only were injected in this group, as we were particularly interested in bone lesions, breast inoculation being used primarily to replenish the stock of tumor tissue. The four chicks not developing any tumor in the first group were inoculated at the same time. All the chicks received 0.2 c.c. of the filtrate into the medullary cavity of the upper end of the tibia.

Of this group:

19 chicks developed bone tumor
6 chicks did not show any lesion.

most respects unlike the typical tumors produced in the group. This tumor resembled the true osteogenic type seen in



FIG. 13. Group 2. High power photomicrograph of tumor seen in Figure 12, showing short spindle cells and new bone production. Spontaneous tumor arising in tarsus was almost identical to this. Chick No. 6.

Two rather interesting phenomena were noted in this group. In the *first place* the four older chicks from group one died within a few hours after the injection. The first one died within an hour and the last one died during the night. On necropsy there were no demonstrable gross lesions anywhere, and the conclusion was that it was an *anaphylactic* reaction for none of the other chicks died until tumors had developed. *Another* chick, No. 6, developed a rapidly growing tumor which was in

man and further description of gross and pathological findings will be found under Figures 11, 12, and 13 and in the pathological descriptions following.

It is interesting to note that in this same chick a tumor identical to that arising at the site of inoculation developed in the tarsal bone of the same leg. This is rather interesting because it was either spontaneous or metastatic which is not often seen in this type of sarcoma. Necropsies were performed on the other chicks of this group

and practically all showed metastatic nodules in the lungs and to a less extent in the liver. The tumors were classified as

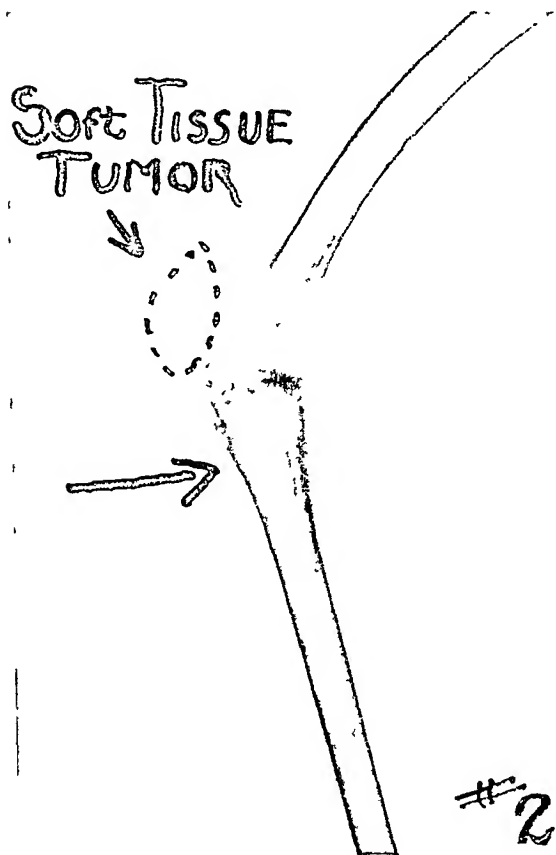


FIG. 14. Group 3. x-ray of chick No. 2, with soft tissue tumor anterior to knee and bone involvement at upper end of tibia.

endotheliomas and ran true to the characteristic form described in the first group. Figures 7 and 8 show such tumors.

GROUP 3.

Six chicks were used in this group due to the fact that it was impossible to obtain the required number at the particular time. These chicks were six weeks of age. The freshly prepared tumor solution filtrate obtained from chick No. 6, group 2 (osteogenic sarcoma) was prepared in the same manner as for groups 1 and 2. Due to the fact that the chicks were larger than those used in the other group, 0.4 c.c. of the filtrate was injected into the upper end of the tibia and 1 c.c. of the filtrate

into the pectoral muscles of the same side. The chicks progressed in the usual manner.

Of this group: 5 chicks developed tumor in tibia and breast. 1 chick developed no tumor.

The first chick, No. 2, died on the twenty-third day. On necropsy, an unusual type of growth was noted about the knee joint and seemed to be entirely free from the bone tumor. It lay in the fascial space anterior to the articulation. It was encapsulated and appeared to be connected to the spot on the joint cartilage where the needle had been introduced into the medullary cavity. The bone was also involved in the process but did not show a remarkable swelling. The breast tumor was the size of a small hen's egg. Figure 14 shows the soft tissue tumor in bone involvement. Pathological description of the tumor is found under Figure 15. This tumor proved to be of the giant cell type. No gross lesions were noted in the liver or lungs. Another chick of this group was also of importance in regard to the production of a different type of tumor. This chick No. 3 died on the twenty-fifth day after inoculation, and showed a well-marked bone tumor, associated with a large breast tumor and considerable soft tissue involvement about the upper end of the tibia. From x-ray it appeared more like the myeloma type seen in humans. There were no demonstrable gross lesions in the liver or lungs (Fig. 18). Pathological description of the tumor apparently placed it in the classification of endothelial myeloma (Fig. 19). The other four chicks died within a few days of each other and all had well-developed breast tumors and bone tumors which resembled those of group 1 and 2, being of the endothelioma type. Small nodules were noted in the lungs of three of these chicks; no liver lesions were noted. The interesting feature of this group was the production of the different types of tumor tissue, the first being the giant cell, the second being the endothelial myeloma type, and the third the endothelioma type.

It would be very interesting to carry on this work on a much larger scale trying to pick out the unusual types of tumor from each

PATHOLOGICAL DESCRIPTION

GROUP 1.

Figure 1 shows the various types as seen

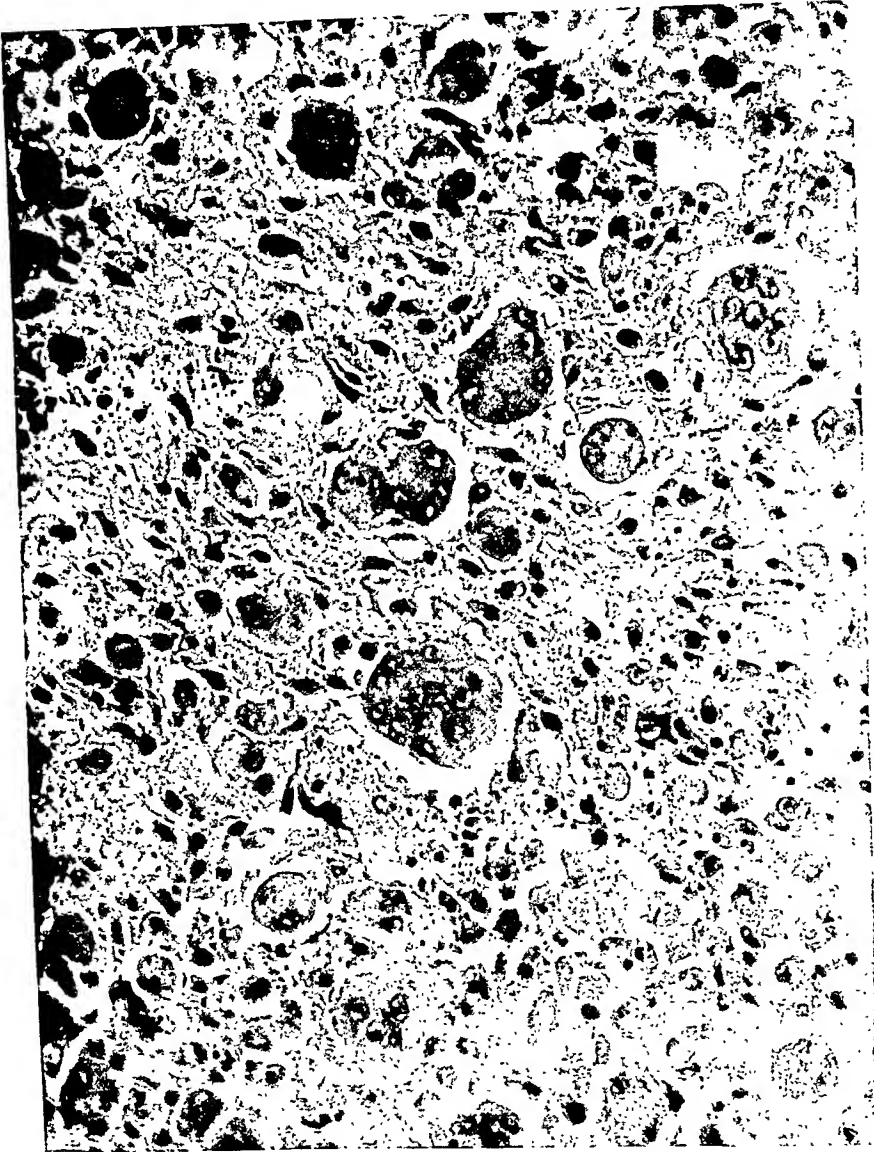


FIG. 15. Group 3. High power section of tumor from chick No. 2, showing characteristic features. Note the large tumor giant cells in loosely woven cellular stroma.

group and transplanting them with the idea of developing other unusual types. All these chicks received the same care and type of filtrate, and it seems from the results obtained that the positive agent is very likely a filterable virus which is capable of producing various local tissue reactions. It might be interesting to experiment further on these lines by the addition of bacterial toxins or chemical agents, to determine if still other bizarre reactions might occur.

by x-ray in group 1.

Gross description, chick No. 3. Sections show a very cellular tumor consisting mainly of rounded and polyhedral cells, with prominent highly chromatic nuclei which are eccentrically placed. There is very little intra-cellular stroma. Throughout the sections are seen occasional scattered giant cells of the tumor type. *High power section* (Fig. 2). Bone (tibia) shows considerable thickening and irregular destruction of the cortex. Tumor

mass encircles the whole upper $\frac{3}{4}$ of the tibial shaft. Tissue appears greyish white, and cuts with considerable resistance.



FIG. 16. Group 3. Gross specimen from Chick No. 4, showing bone destruction and soft tissue involvement.

Both lungs showed diffuse nodular metastases. A few whitish nodules seen in the liver, similar histologically to bone picture. Other organs were apparently free from involvement.

Figure 3 is a moderate high power section showing metastases in the lung from chick No. 3. The cells appear to be of the same type as those seen in the original bone lesion.

Figure 4 is the high power section showing the growth in the liver of chick No. 9. Histologically the picture is that of an epithelial growth and differs markedly from that seen in the primary bone lesion. The neoplasms characterized by masses of cells arranged in broad branching tufts and strands separated by fine connective tissue. The nuclei stained red; the cytoplasm is faintly stained and finely granulated.

*Report by Dr. A. P. Stout.*¹ Microscopic. "Sections show that the tissue must have undergone considerable autolysis for it stains very poorly and shows on one margin a bit of liver. Adjacent to this is a large tumor mass composed of long tortuous strands of cuboidal cells which seem to lie loosely in spaces in a stroma of loose fibrous tissue. The cells are in an advanced stage of degeneration. They have nuclei which stain bright red. The cytoplasm is granular and vacuolated. With fiber stains it can be demonstrated that there are no fibers between the cells. In the stroma are many mononuclear inflammatory cells with large acidophilic granules in the cytoplasm. The picture is that of a malignant tumor, but it appears much more like a carcinoma than a sarcoma." The diagnosis of carcinoma has been confirmed by Dr. J. E. McWhorter and Dr. F. W. Stewart of the Memorial Hospital.

Figure 5 is a silver stain preparation in chick No. 9, demonstrating the scanty fibrous elements of the tumor seen in Figure 4.

Figure 6 is a high power section from a metastatic carcinoma involving several long bones in the human which shows the similarity of the tumors seen in Figure 4.

GROUP 2.

In Figure 7 we have the x-ray appearance of several tumors produced in group 2. Various types of reaction are noted in the different specimens, some showing expansion and thinning of cortex, others showing

¹Pathologist to the Presbyterian Hospital, Medical Center, N. Y. C.

both expansion and thickening of the cortex.

Figure 8 is a high power section of the

Figure 9, a medium power section of tumor in bone chick No. 17, shows a compact mass of cells completely replacing

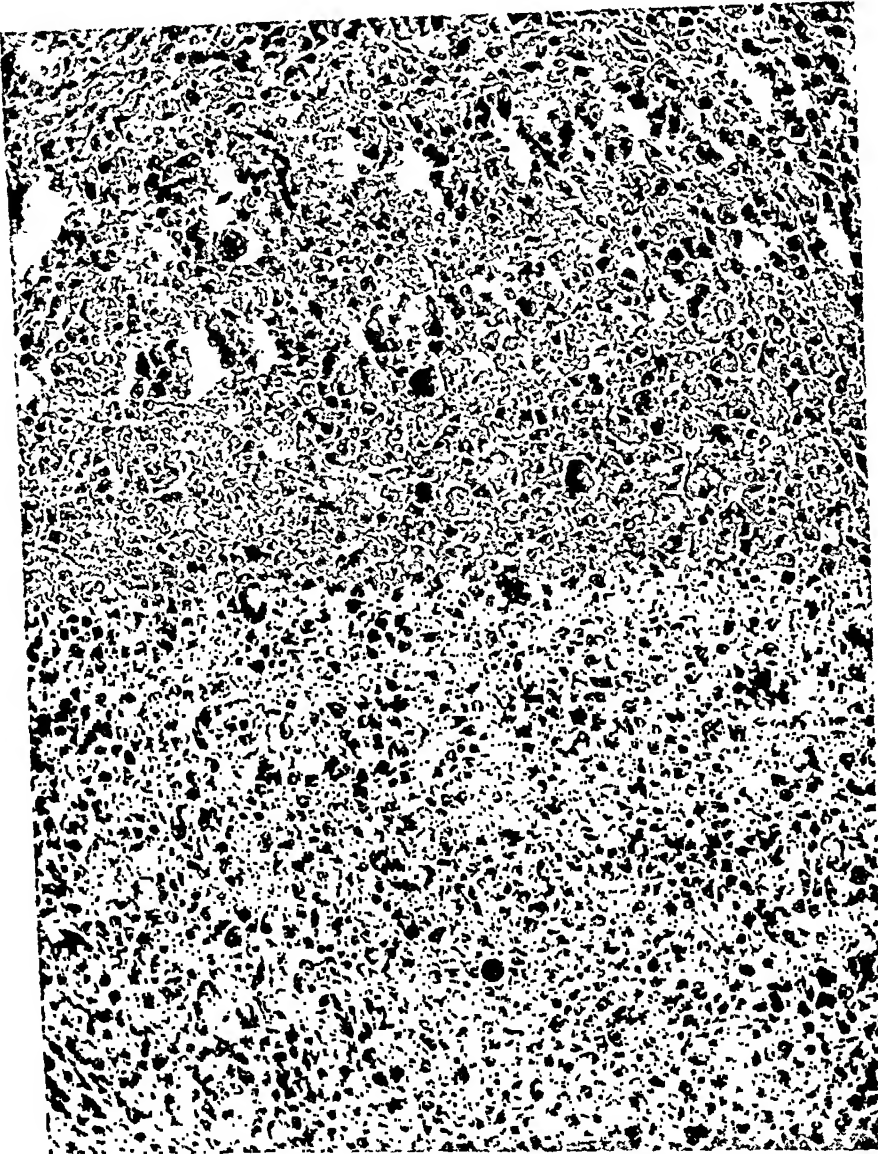


FIG. 17. Group 3. High power section of tumor in chick No. 4, showing closely packed cells of the plasma type. Occasional giant cells are seen.

bone tumor from chick No. 4, showing masses of polyhedral or short spindle type of cells with hyperchromatic nuclei in a very loose connective tissue stroma. Throughout the section, numerous blood vessels are seen, many of which appear to be lined by tumor cells. There are a few rather large spaces lined with a thin layer of endothelium and tumor cells. No giant cells are noted in this section. Cells appear to be of the endothelial type.

the normal medullary tissue and invading and destroying the endosteum. The lacunae in the bone are filled with the tumor cells. There are a few scattered giant cells seen throughout the section. There is very little evidence of new bone formation. Cells appear to be of endothelial type.

Figure 10 shows the gross specimens of chicks No. 17, 5, and 1. Note the marked bone destruction in the region of the tumor in No. 17. The tumor was of grayish white

hue firmly attached to and invading the bone, with evidence of cellular growth extending well into the medullary cavity

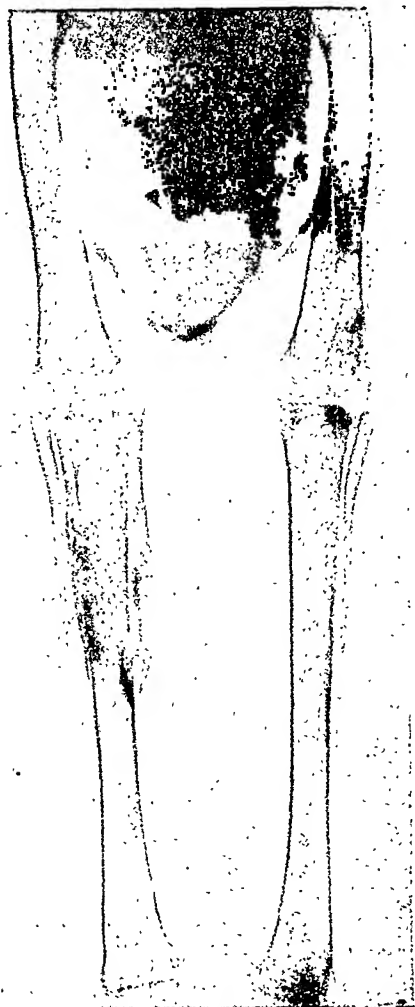


FIG. 18. Group 3. x-ray of tumor in chick No. 3, showing bone destruction, and production in laminated lines closely resembling the Ewing type.

on both sides of the central location. Specimens 5 and 1 show varying degrees of bone involvement, the cortex being almost completely destroyed in No. 1 as shown in the specimen and being replaced by tumor tissue.

Figure 11 is an x-ray showing the bone involvement in chick No. 6 in which the upper half of the tibia shows marked new bone and cartilage formation, radiating spicules of bone and varying degrees of destruction throughout. The soft tissue

tumor can be well demonstrated when compared with the opposite leg. This appears to be a typical osteogenic sarcoma.

Figure 12 shows a low power section of the tumor shown in Figure 11. The remaining cortex can be seen in the center of the picture with marked proliferation of new bone and tumor tissue radiating at right angles to the shaft.

Chick No. 6 on gross examination showed two well-developed bone tumors, one of which developed at the site of inoculation in the upper end of the right tibia, the other arising spontaneously in the tarsal bone of the same side. Grossly, both appeared to be identical in structure and new bone production. There appeared to be considerable cartilage throughout the mass. The lungs showed metastatic nodules ranging in size from 0.75 cm. to fine pin point nodules. Marked emaciation was noted. Nodules in lungs were histologically similar to the bone lesion.

The high power picture (Fig. 13) of a spontaneous tumor arising in a tarsal bone of chick No. 6, shows it to be histologically identical to that seen in the primary tumor arising in the tibia (Fig. 12). Tumor is characterized by marked new bone production with an abundance of spindle cells filling the spaces between the trabeculae. The nuclei of these cells are hyperchromatic and appear to be of the rapidly growing type. New bone is for the most part laid down in disorderly fashion but tends to form in seemingly parallel lines. Picture is histologically comparable to that seen in the human osteogenic type of sarcoma.

GROUP 3.

Figure 14, x-ray of chick No. 2, group 3, shows the bone involvement and the soft tissue tumor anterior to the knee joint arising from inoculation with filtrate from chick No. 6 of group 2 (osteogenic). There is some thinning but very little expansion of the cortex of the bone; a few vacuolated or cystic areas can be seen in the upper end

of the tibia. Soft tumor connected with tumor at upper end of the tibia. elongated and fusiform. A few scattered round cells are seen in some of the sections.

Figure 15, a high power section of the

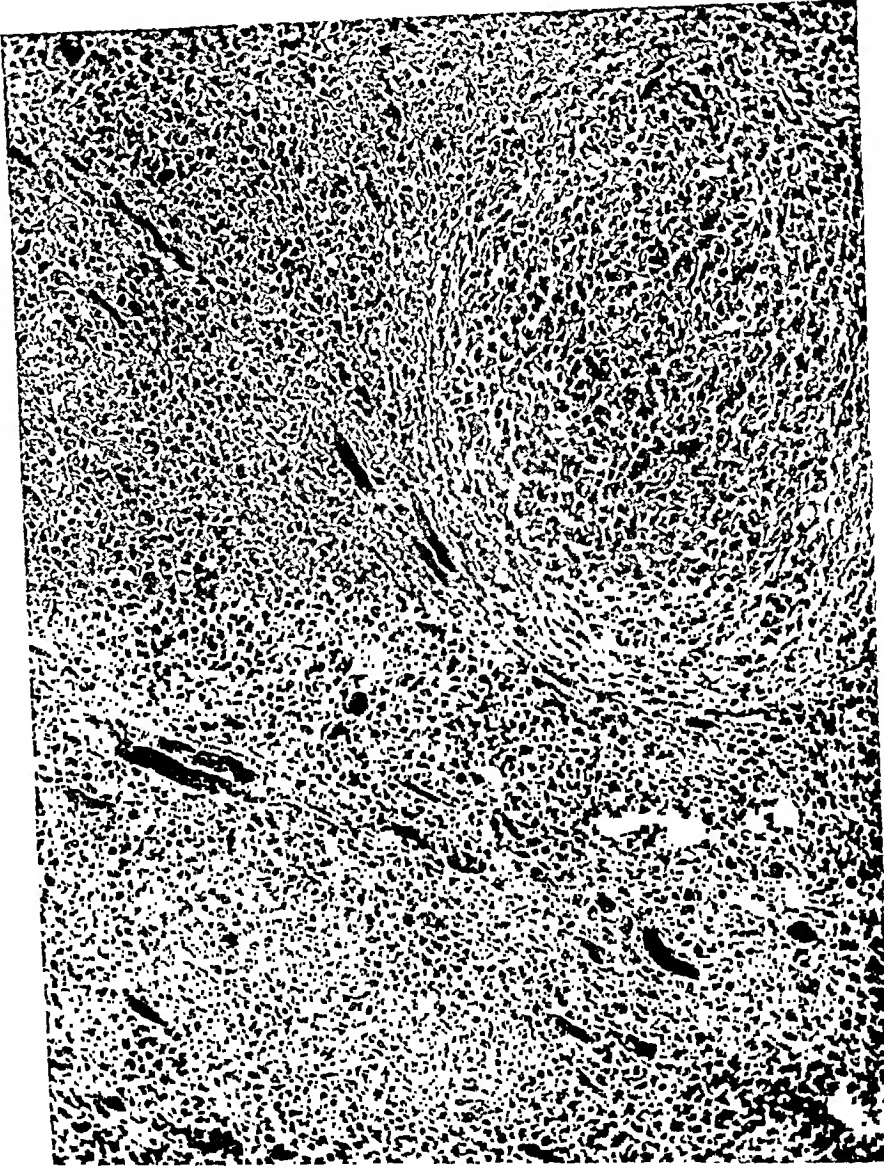


FIG. 19. Group 3. Medium high power section of tumor seen in Figure 18. Note similarity to picture seen in Ewing type of sarcoma. Chick No. 3.

tumor seen in Figure 14, chick No. 2, group 3, shows an exceedingly cellular stroma consisting largely of fine connective tissue fibrils; profusely scattered throughout the latter are many large giant cells, the structure of which rather closely resembles those associated with the giant cell tumor seen in the human. Many of the giant cells show as many as twenty nuclei. These cells are for the most part rounded or oval in shape, although some of them are

Figure 16 shows the gross specimen of chick No. 4, group 3. The great amount of bone destruction can be noted with invasion of the medullary cavity by the tumor cells, which can be seen connected with the extracortical tissue through a break in the shell of bone. No metastatic nodules were noted in this particular case in the liver or lungs. Chick died on the twenty-third day after inoculation with marked wasting of all the skeletal musculature.

Figure 17, a high power section of the tumor in chick No. 4, group 3, shows a very dense cellular matrix of closely packed

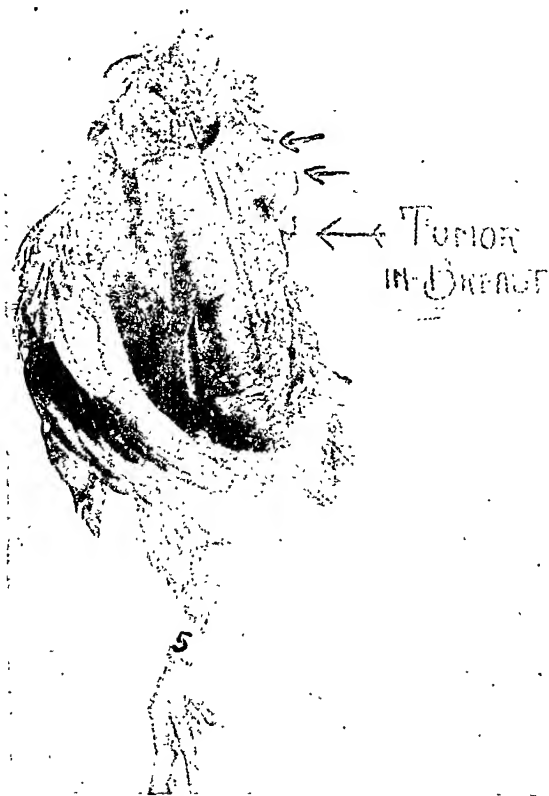


FIG. 20. Group 3. Typical breast tumor developed in group 1. Chick No. 3.

rounded or polyhedral cells with eccentric hyperchromatic nuclei and finely granular cytoplasm. Cells appear to be similar to the plasma cell type. There are a few giant cells present which for the most part have two or three nuclei. In some areas the sections show a few embryonal cartilage cells and the endosteum of bone appears to be undergoing destruction and regeneration.

Figure 18 is an x-ray picture of chick No. 3, group 3, showing a bone involvement. In the upper third of the tibial shaft is a rather sharply demarkated area of diminished density showing quite distinct striations. The cortex is thin but not markedly expanded and in the lower aspect of the tumor appears to be broken through and connected with the soft extracortical mass.

New bone is being laid down throughout the section.

Gross Pathology. Chick No. 3. The bone specimen showed a marked thickening about the upper half of the right tibia. The tumor mass was deeply attached to the bone and nonfluctuant. On section the cortex appeared to be broken in several areas and through these channels the cellular element infiltrated the soft tissues. The bone destruction was more marked than the x-ray would suggest. No tumor nodules were seen grossly in the lungs or liver but there was a marked degree of wasting of all the skeletal muscles. Chick died on the twenty-ninth day after inoculation.

Figure 19, a medium high power section of tumor from chick No. 3, group 3, shows a diffusely infiltrating mass of rounded and polyhedral cells having a somewhat mosaic arrangement. These cells are arranged in whirls and circular masses. Some of the masses are arranged around the central blood vessel or sinus. The general appearance of these cells and their arrangement strongly suggests endothelial origin. In these respects the tumor closely resembles Ewing's sarcoma.

Figure 20, Gross specimen, shows the breast tumor developed in the first group of chicks. The nodules in the liver are rather indistinctly shown in the figure. The bone tumor had been removed for pathological study.

PATHOLOGICAL SUMMARY

Practically all of the chicks in which bone or breast tumors developed showed metastatic nodules in the lungs and liver. The typical lesions have been described in the legends to the illustrations. All of the chicks showed marked wasting of the skeletal musculature. It is interesting that in the Ewing's type, the Giant cell type, and the plasma cell type seen in group 3, the nodules were not noted on necropsy. As has been pointed out, most of the chicks developing tumors died within a period of from fourteen to thirty-three days.

No spontaneous disappearance of either breast or bone tumors was noted. One spontaneous fracture was noted in Chick 4 of group 2 (Fig. 7).

CONCLUSIONS

In summarizing the results of this set of experiments two important facts are presented.

1. The artificial production of malignant tumors derived from filtrates of dried tumor tissue.

2. From the artificially produced tumor tissue filtrates, other malignant tumors have been produced which are dissimilar in respect to morphology, histology and dissemination of metastatic nodules.

3. Culture of dried tissue, and filtrate on usual media showed no growth, but

on special media positive cultures were obtained in all tubes with the dried tumor tissue (6); and one showed growth with the filtrate.

The tumors produced have been classified from x-ray, gross, histological, and clinical examinations in the following types:

1. Endotheliomas,
2. Endothelial myeloma.
3. Osteogenic sarcoma.
4. Giant cell tumor.
5. Epithelial tumor.

The author wishes to express his appreciation and gratitude to Dr. W. E. Gye who so kindly furnished the original dried tumor tissue used in this work; and to Drs. W. B. Coley, J. E. McWhorter, A. P. Stout, R. W. Lewis and the laboratory technicians for their very kind and helpful assistance in preparing this work for publication.

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COMBINED ROENTGENOLOGIC AND CLINICAL DIFFERENTIAL DIAGNOSIS OF BENIGN & MALIGNANT LESIONS OF THE STOMACH*

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IN Europe, especially on the Continent, the roentgenologist has never forsaken his status as a clinician, and roentgenologic interpretation is made in the full light of the clinical facts. In America, as a rule, the roentgenologist and clinician conduct their respective examinations independently. Save for clinical data which are obvious, such as the age, sex, and general appearance of the patient, the roentgenologist bases his opinion solely on roentgenologic signs. The clinician likewise endeavors, from the anamnesis and physical signs only, to make at least a provisional diagnosis in order that he may select appropriate laboratory tests and examinations. Later, when he has learned the results of these tests, including the results of roentgenologic examination, he canvasses all the data anew, confers as he deems necessary with others who have participated in the examination, and makes the final diagnosis.

An outstanding advantage of this method is that both roentgenologist and clinician are enabled to conduct their primary investigations without prejudice, and are impelled to derive a maximal amount of information solely from them. This plan has markedly stimulated progress in each line of endeavor, and has aided so substantially in improving diagnosis that it is likely to continue in favor. It provides for correlation of all data in arriving at a final diagnosis, and this paper is directed to the necessity of adequate correlation in order to distinguish between benign and malignant lesions of the stomach.

During recent years the profession has sought, by lectures, publications, and radio

broadcasts to impress the public with the necessity of frequent medical examinations in order that carcinoma, wherever situated, may be discovered and extirpated at a time when the chance of cure is not hopeless. To the patients who are beginning to respond to this appeal the physician has imposed on himself an augmented obligation to find existing carcinomas, including those of the stomach, with greater accuracy and at an earlier stage than formerly, and to distinguish them from other lesions with greater precision.

Grossly, carcinoma of the stomach may take the form of frank tumor, infiltrative neoplasm without obvious tumefaction, ulcer without manifest proliferation, or ulcerating tumor in which both ulceration and tumefaction are marked. In advanced cases of all four varieties there are typical instances in which roentgenologic signs are fairly decisive. For example, a medullary carcinoma producing a gross filling defect and a palpable mass, an extensive scirrhus carcinoma narrowing the gastric lumen to an irregular funnel, a huge carcinomatous ulcer with a diameter of 3 or 4 cm., or an ulcerating carcinoma with a deep crater encircled by a prominent ridge, is not likely to be confounded with any of the benign diseases. Likewise, in all four varieties there are many instances in which the anamnesis and the clinical examination are reasonably diagnostic. For example, if a patient is of more than middle age, gives a history of vomiting material which has the appearance of coffee grounds, has lost greatly in weight, is patently anemic and cachectic, and has a palpable mass in the epigastrium, a tentative clinical diagnosis of gastric

* Read before the American Gastro-Enterological Association, Atlantic City, N. J., May 4 and 5, 1931.

carcinoma seldom will be wrong. Yet, no matter how emphatic the clinical or roentgenologic evidence alone may be, the other method of examination cannot safely be omitted, and definitely discordant results from these tests call for further investigation.

Even when gastric lesions are extensive and conspicuous the roentgenologist may err occasionally in distinguishing between carcinoma and a benign neoplasm or syphilitic infiltration, or between a large carcinomatous ulcer and a simple ulcer, notwithstanding the application of differential criteria which are usually trustworthy. Massive soft carcinomas are almost invariably single; they are sessile, and produce deep, irregular marginal defects; peristalsis is absent from the region involved. Benign neoplasms are often multiple, usually pedunculated, produce smoothly rounded central defects, and do not interrupt peristalsis. Exceptionally, however, any or all of these marks of distinction fail, and a malignant tumor is adjudged to be benign, or the contrary. Extensive infiltrating scirrhus carcinoma most often causes a funnel-shaped deformity, with an irregular lumen, and the affected gastric wall is palpable. Syphilis tends to convert the affected gastric segment into a narrow tube with a relatively smooth lumen of uniform caliber, and the gastric wall is almost never palpable. Yet there are instances in which scirrhus carcinoma, especially the variety sometimes designated fibromatosis, is mistaken for syphilis, or vice versa. An ulcer with a niche exceeding 3 cm. in diameter, although in all other respects it may have the appearance of a simple ulcer, is likely to be malignant, and the roentgenologist would be remiss if he failed to report this probability but, even though rarely, large ulcers sometimes prove to be benign (Fig. 1). In all such extraordinary cases the clinical history, analysis of gastric content, blood count and Wassermann test have an increased significance and may set the diagnosis right. Con-

versely, an erroneous primary clinical opinion may be corrected by unequivocal roentgenologic data. It is to be emphasized,

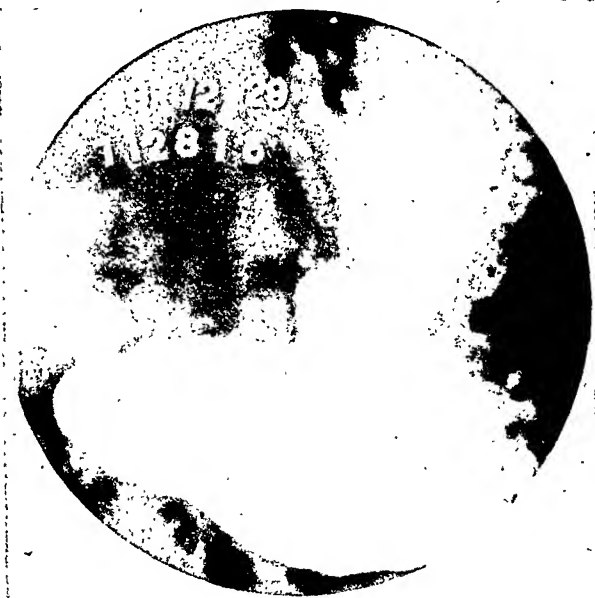


FIG. 1. Large ulcer on lesser curvature which, on the basis of its size, should have been malignant. Clinically the history was indicative of simple ulcer. At operation the ulcer proved to be benign.

however, that errors will persist unless coöperation between roentgenologist and clinician is active, intimate, and thorough.

Far more difficult is the determination whether niche-ulcers, not unduly large, or small prepyloric lesions, are benign or malignant. In both groups, roentgenologic distinction, when feasible at all, requires close observation not only of the slighter morphologic changes, but also of the secondary and functional phenomena. Similarly, the clinician is obliged to take cognizance of lesser subjective and objective manifestations, and to weigh them with scrupulous care. Although neither examiner alone can often make positive decisions, he will at least derive an impression as to the benignancy or malignancy of a lesion, and a summary of the facts derived from all sources may show a definite preponderance of evidence on one or the other side.

On an empiric basis, the roentgenologist can assert rather positively that a perforated ulcer, with an accessory pocket

outside the stomach, is benign, and that an ulcer the crater of which is surrounded by an elevated wall is malignant. He can

away from the lesser curvature, are more likely to be malignant than those on or near the lesser curvature. Ulcers on the



FIG. 2. Small, perforated ulcer on lesser curvature accompanied by marked spasm. Roentgenologically, it had all the features of a benign ulcer. Clinically it was suspected to be malignant on account of the short history. At operation the ulcer was found to be malignant.

also be fairly confident that a niche ulcer with a diameter greater than 3 cm. is malignant, but niche ulcers of smaller dimensions bear no patent indications of their nature (Fig. 2) and less obvious signs have to be sought and considered. Among such signs are the following:

Most niche ulcers are benign, and on a statistical basis such an ulcer is presumptively not malignant unless atypical features are present. A sharply conical or irregularly contoured niche is suggestive of malignancy; the niche of a benign ulcer is usually regularly hemispherical. A simple ulcer more often has a dense, clearly depicted niche; a malignant ulcer more often has a faintly shadowed ill defined niche. Ulcers on the posterior wall, well

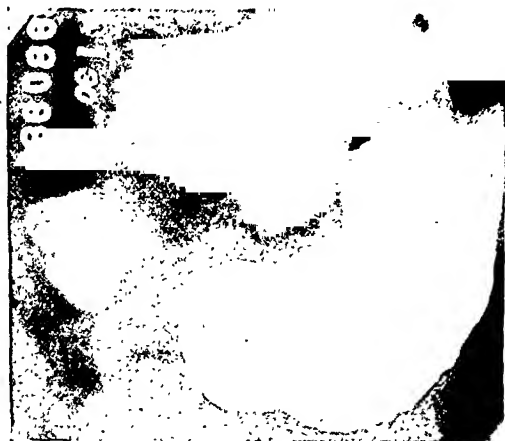


FIG. 3. Concentric prepyloric filling defect and an extensive defect at the cardia. A carcinoma at the cardia and a second carcinoma at the pylorus were discovered at operation. The roentgenologic appearance of the prepyloric lesion is comparable to that shown in Figures 4, 5 and 6.

greater curvature, where they are rare, are almost invariably malignant. Ulcers near the pylorus are more likely to be malignant than those distant from the pylorus. An ulcer with obliteration of the neighboring rugae is probably malignant; an ulcer in the midst of exaggerated and converging rugae is probably benign. Localized gastrospeasm is a feature of benign ulcer. An ulcer accompanied by an incisura, antral spasm, a tightly closed pylorus, or spastic retention, is probably benign; a gaping pylorus, or absence of all spastic phenomena, suggests that the ulcer is carcinomatous. Active peristalsis speaks for simple ulcer; faintness or absence of peristalsis speaks for carcinoma. An ulcer on the lesser curvature, in the antral portion of the stomach, accompanied by curling of the curvature and inclination of the bulb toward the median line, is probably not carcinomatous; absence of curling is ground for suspecting that the ulcer is malignant. Sharply localized tenderness over a niche is rather indicative of simple ulcer; a malignant ulcer is seldom tender.

Although small, prepyloric lesions are readily discernible, as a rule they can seldom be identified confidently (Figs.

all resectable carcinomas, ulcerating and otherwise, temporarily simulate peptic ulcer, especially at the outset, and more

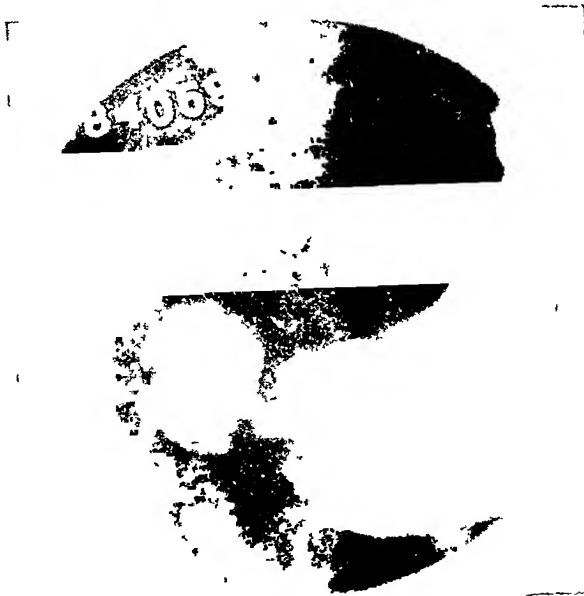


FIG. 4. Concentric prepyloric filling defect. A simple ulcer was found at operation. Compare with figures 3, 5 and 6.



FIG. 5. Concentric prepyloric filling defect. On resection the lesion proved microscopically to be syphilitic. See Figures 3, 4 and 6.

3, 4, 5, 6). Early scirrhus carcinoma, syphilis, prepyloric ulcer and hypertrophy of the pyloric muscle frequently produce exactly similar deformities. Malignant ulcers and simple ulcers often have no distinguishing marks, and small malignant tumors may assume the guise of those which are benign. Curling up of the antrum, preservation of rugae, active peristalsis, spastic retention and localized tenderness may incline the diagnosis toward simple ulcer. Obliteration of rugae, sluggish peristalsis, a patent pylorus, and absence of tenderness, may suggest that the disease is malignant. But too often the roentgenologist is obliged to content himself with reporting, "lesion at the outlet." In all such cases the clinical factors, combined with the roentgenologic features, may prove helpful.

On the clinical side, contrary to the opinion of certain observers, the majority of benign gastric ulcers present the classical syndrome of ulcer, although not to the same degree and frequency that characterizes duodenal ulcer. About a fourth of

than half of all resectable carcinomatous ulcers give rise to the same symptoms, usually over a longer period of time.



FIG. 6. Concentric prepyloric filling defect, which at operation was found to be due to hypertrophy of the pyloric muscle. Compare with Figures 3, 4 and 5.

Under such circumstances the carcinomatous nature of the lesion, or the transformation of a benign ulcer, may be evidenced symptomatically by one of the

following: (1) disappearance of intermittency of the exacerbation, with substitution of a remittent or continuous clinical course; (2) irregularity, diminution or disappearance of the pain-food-ease sequence; (3) substitution of the usual pain or distress by a dull ache, more or less constant and eventually aggravated rather than eased by alimentation, and (4) loss of appetite and onset of nausea, both of which may ensue, even in the presence of adequate gastric acidity. Objectively, diminution in gastric acidity, disturbance of motor function, onset of anemia in the absence of gross hemorrhage, the appearance, the increase, or the persistence of occult blood in the gastric content and feces during a meat-free regimen are significant. Symptomatic changes are less significant if complications have developed, such as penetration, with involvement of other viscera, extensive perigastric adhesions, and hour-glass deformity. On the other hand, lesions which from a roentgenologic standpoint could be benign may have presented from the onset those symptoms and signs invariably associated with, or characteristic of, frank or even advanced carcinoma.

Although many verified benign gastric ulcers have their onset, at least symptomatically, in the carcinoma age, the combination of advanced age and symptoms of recent appearance should always arouse suspicion of malignancy, even though the lesion may be small. If, also, the anamnesis reveals an irregular or atypical syndrome of ulcer or certain departures from the normal results of analysis of gastric content, or an early tendency to gastric retention or obstruction, the lesion should be regarded as carcinomatous until proved to be otherwise. Judging from our experience, and that of others, the situation of the lesion is of relative significance in differential diagnosis because lesions that are near the pylorus, or on the posterior wall, or near the greater curvature of the stomach, have a greater tendency to be carcinomatous than those on the

lesser curvature, or those in the vicinity of the incisura angularis, where most benign ulcers are situated. In the type of lesion under consideration, the general examination is of secondary importance, for only rarely is metastasis recognizable by the examination.

Analysis of gastric content is an indispensable procedure, particularly in debatable cases, and on occasion is the most important link in the diagnostic chain. The usual observations in the frank, advanced, or obstructing form of carcinoma are familiar to all. In our enthusiasm for this procedure as a diagnostic aid, it must be remembered that these familiar data are characteristic chiefly when other diagnostic methods are decisive, or when the condition is obvious. In more than 50 per cent of resectable lesions, and in about 80 per cent of pathologically verified carcinomatous ulcers and small ulcerating carcinomas, free hydrochloric acid is present. In the latter two types, the secretory volume, and the degree of titratable acidity after the alcohol test meal and the stimulus of histamine are usually identical with that of benign ulcer. However, it may be said that hypochlorhydria is the rule, and that the combination of achlorhydria and subacidity is noted in about two-thirds of all cases of carcinoma. The fact that in 60 per cent of resectable lesions, and in 40 per cent of small carcinomatous lesions gastric retention is present is of some significance, especially if this complication develops early in the course of the disease.

With nonobstructing lesions situated on the posterior wall and pars cardiaca, often difficult of visualization by the roentgenoscope, there may be achlorhydria or hypochlorhydria, and blood in the gastric content, and such observation justifies sending the patient back for another roentgenologic examination; the lesion invariably will be visualized after one or more succeeding examinations. Rarely is a gastroscopic examination necessary in these cases. Occasionally carcinomatous

tissue has been recovered from the stomach tube or in the washings. Some of these small lesions, irrespective of their situation, may be accompanied with achlorhydria, blood, lactic acid, or the long bacilli from the outset; thus early differentiation is simple. It should be remembered that in about 5 per cent of all chronic cases of benign ulcer, achlorhydria may be present following a standard test meal and fractional analysis, whereas gastric retention and pyloric obstruction is not uncommon in both benign and malignant lesions, although the incidence is several times greater in the latter.

Constitutional and hereditary factors come in for some consideration, but much remains to be learned in this regard. Carcinoma has a predilection for persons whose constitution may be regarded as normal, or almost normal. Previous good health and digestion are characteristic of the majority of patients with primary gastric carcinoma. If the patient in a given case presents a family history of many carcinomas in several generations, one is inclined to regard the lesion as actually or potentially malignant, and to favor radical methods of treatment.

The results of observation in hospital and adequate medical treatment in difficult cases are often decisive in determining the true nature of the lesion, which is not possible by cursory examination in the consulting room. It may be taken for granted that lesions which undergo complete anatomic restoration and symptomatic recovery, are benign. Failure to achieve this result, however, does not signify that such lesions are carcinomatous, for complications of various kinds, often determinable before or in the course of treatment, may forestall cure in about 40 per cent of cases. In the remainder, the lesion will prove to be malignant. Since it is impossible to distinguish with certainty between the intractable and the malignant lesion, it is essential that surgical interference be undertaken without unnecessary delay.

To summarize, the carcinomatous nature of a small, circumscribed gastric lesion may be evidenced clinically by: change in the character of the clinical course and symptoms, progressive anemia in the absence of gross hemorrhage, loss of weight and strength that is out of proportion to reduction in aliment, a combination of advanced age and recent symptoms, early gastric retention and achlorhydria, or even free acid in the presence of obstructing juxtapyloric lesion, without visible filling defect, blood in the gastric content and persistent achlorhydria, residuum in a fasting stomach in the absence of retention of barium for six hours, occurrence of many instances of carcinoma in several generations, and failure to secure anatomic restoration and symptomatic relief by adequate treatment.

Clinical differentiation of gastric carcinoma from benign gastric tumor is beset with many difficulties for there are many features, differing only in degree, that are common to both lesions. Roentgenoscopic examination as a routine, with a growing familiarity with this type of disease, is largely responsible for the increasing number of individual cases reported from various sources. Clinical features which help in the diagnosis of benign gastric tumors, and which help to distinguish them from malignant gastric tumors are: (1) low incidence, for the ratio of benign to malignant tumors is 1 to 200; therefore, when in doubt, the law of probability would largely favor the diagnosis of carcinoma; (2) absence, or mildness, of dyspeptic symptoms, coupled with good nutritional state and low incidence of obstruction and palpable mass; (3) anemia and gastro-enteric hemorrhage as the outstanding and often the sole symptoms or signs; gross hemorrhage is unusual in gastric carcinoma, especially early in the course of the disease; secondary anemia, rarely a primary form, in the absence of hemorrhage, may be the only feature noted; in fact, anemia is the most common symptom and sign; (4) normal

gastric acidity and secretory volume; this is a common observation, and (5) the age of the patient; several of the largest tumors were in children. Therefore, the benign nature of the tumor may be indicated by these characteristics, usually present in combination, especially when they are combined with the roentgenographic delineation of a lesion exhibiting the signs previously described.

To distinguish gastric syphilis from other gastric lesions, particularly carcinoma, usually requires the closest cooperation between the roentgenologist and internist or syphilologist. The disease is extremely rare, occurring on the average only three times in every 1,000 patients with syphilis in our series, and when gastric syphilis was present, neurosyphilis, carcinoma and duodenal ulcer were more frequently the cause of gastric malfunction than was the specific lesion. The symptom-and-sign syndromes are not infallible, evidenced by the fact that many of the authentic cases were diagnosed roentgenologically as carcinoma. Clinical criteria, exclusive of those based on the effect of antisyphilitic treatment and adequate follow-up observation, also have their shortcomings because of subjective and objective features common to both gastric syphilis and carcinoma, and in lesser degree, to benign ulcer. Moreover, recognition of clinical evidence of syphilis is less significant in the diagnosis of gastric syphilis than is the presence of concomitant data in favor of the other two types of lesion, because the incidence of positive clinical signs of syphilis was almost as high among patients who had syphilis and gastric carcinoma or gastric ulcer as among those with gastric syphilis.

We are here chiefly concerned with the differential diagnosis of syphilitic, benign, and small carcinomatous ulcer, for we are more familiar with the differential aspects of extensive lesions producing filling defects which so closely simulate gastric carcinoma. The small, circumscribed roentgenoscopically visualized le-

sion, if the patient has syphilis, may be benign, carcinomatous or syphilitic. In our experience it is very uncommon for a circumscribed syphilitic lesion to mimic benign gastric ulcer, symptomatically or objectively. Gastric lesions of a chronic recurring nature, in the presence of the characteristic syndrome of gastroduodenal ulcer, and with adequate acidity, are invariably benign and not etiologically linked with the systemic infection. However, fairly authentic cases of gastric syphilis, with a niche and free hydrochloric acid in the gastric content, have been reported. The small ulcerating carcinoma may give rise to greater difficulty in diagnosis, for in its symptoms, roentgenologic appearance, and nature of the gastric content, it may be indistinguishable from syphilitic ulcer. In such cases, satisfactory differential diagnosis is possible only by abdominal section and histopathologic study of the excised or resected lesion, or by drawing the logical conclusion that the ulcer is actually syphilitic if the defect disappears and symptomatic recovery follows antisyphilitic treatment.

A better understanding as to the frequency with which syphilitic ulcers of the stomach may present themselves with roentgenologic and clinical characteristics indential with, or approximating, those of benign ulcers and small carcinomatous ulcers, is possible only by regarding every circumscribed gastric lesion of a patient with syphilis as syphilitic in nature until proved otherwise. Judging from our experience, this phenomenon is rare, for in only two cases was it present; in one case it was verified at operation and in the other cure was effected by treatment. On occasion, multiple, contiguous, benign gastric ulcers may produce the same filling defect as carcinoma, and when this occurs in a case in which the patient has syphilis, errors in diagnosis are excusable. Even under such circumstances, the symptoms and chemical changes in the gastric content in cases of benign ulcer usually present themselves, which with satisfac-

tory results obtained from treatment on the basis of a benign ulcer, may deter the circumspect clinician from error.

It is from such roentgenologic and clinical data that distinction between benign and malignant disease often must be made, if it can be made at all. Every case constitutes an individual and novel problem, for the signs and symptoms vary endlessly in their emphasis, in their combinations, and in their weight in particular circumstances. Through the years, efficiency in the diagnosis of carcinoma has increased progressively, but the complexity of interpretation has also increased. Further advances can be made only by discovering new methods of investigation, by more intensive cultivation of those now at hand, or by more thorough correlation of facts at present obtainable. This paper has been devoted to the third alternative. There is no implication that either clinician or roentgenologist should invade the province of the other. On the contrary, we earnestly believe that they should continue to limit themselves to their respective fields and develop them further toward perfection. But it is felt that this separation is sometimes too rigidly practiced, that communication between them is too often restricted to a brief formal report in which neither examiner will venture beyond facts of which he is certain, and that the less definite impressions should not be discarded, but compared and discussed in personal conference. From such conference may come an illuminating reexamination, a more explicit opinion, or a specific and accurate diagnosis.

DISCUSSION

DR. M. FELDMAN (Baltimore): The last cases Drs. Eusterman and Kirklin showed are those that are well advanced. The differential diagnosis between ulcer and cancer becomes increasingly more difficult in the early stages. This is true both from a clinical as well as a roentgenological standpoint. Roentgenologically we depend principally upon the presence of a filling defect in the diagnosis. The filling defect is usually characteristic and presents

itself in the forms Dr. Kirklin showed; one as a projective type and the other as an invading type defect. There is, however, a certain percentage of cases which do not reveal the usual pathognomonic filling defect and in order to make a diagnosis one must rely on the secondary signs, especially in the early cases. By grouping these signs with the clinical picture and other laboratory tests an early diagnosis is possible in many instances.

I would like to emphasize the importance of repeated x-ray examinations as especially necessary in the study of gastric lesions.

DR. SARA M. JORDAN (Boston): It seems to me that this paper is very important as showing the necessity for cooperation between the roentgenologist and the clinician; not only, however, to make the diagnosis when the patient first comes in, but also to follow the patient along during the necessary medical management in borderline cases. We have found that a great many cases fall in the group which are borderline, neither out-and-out carcinoma nor out-and-out ulcer. If we put them in the hospital and put them on a definite regime of medical management for a period of time, usually not more than two weeks (rarely two weeks; it is usually about a week or ten days) we find that three things must occur if we are to assume that these patients have benign ulcer.

First, that the lesion must disappear by x-ray. There must be no evidence of a deformity.

Second, that occult blood must disappear from the stools.

And third, that the patient must be completely relieved of symptoms.

I said that it was necessary to prove that the patient had a benign ulcer. I should add that some of the benign ulcers heal to the point where the radiological defect is just a dimple. But that dimple remains there and these cases later turn out to be benign but recurrent ulcers. In those cases we also advise surgery because we do not like the patient to go out with an ulcer defect which we think indicates a future recurrence of trouble.

Regarding the size of the lesion, I was very much intimidated several years ago by two very large lesions on the lesser curvature side of the stomach which because of their size seemed to me suspicious of malignancy. But these lesions disappeared completely and the patients are well today after several

years. So we feel the size of the lesion is not one of the criteria to which we must pay attention.

Regarding prepyloric deformity, that has given us a good deal of difficulty because it may be due to either spasm or ulcer or carcinoma or carcinomatous ulcer, and it is in some of the cases with spasm that we have had considerable question. Patients have been sent to us from roentgenologists with a diagnosis of carcinoma at the pylorus and after a week of treatment that carcinoma has proved to be nothing, the stomach then being entirely normal and the original deformity having been due to spasm.

DR. W. L. PALMER (Chicago): I should like to emphasize the fact that x-ray is, after all, merely an adjunct of medicine, one of the diagnostic methods at our disposal. Before making the final diagnosis, the internist should have at hand not only the report of the x-ray findings, but also the films, and, more important still, the privilege of fluoroscopying the patient himself. The diagnosis should be based upon all of the evidence available, clinical, laboratory and roentgenologic.

As far as x-ray findings are concerned, I think we should insist upon direct signs of carcinoma, the direct signs of ulcer. It seems to me the findings the second speaker mentioned, the secondary findings of carcinoma, are really direct findings of carcinoma: the rigidity or fixed condition of the lesser curvature.

I would like to ask two questions. One, of Dr. Kirklin, whether he is sure belladonna will relax gastric spasm. And the other one of Dr. Eusterman: how accurately is it possible for the internist with closest cooperation of the roentgenologist to differentiate between benign and malignant gastric lesions?

DR. H. L. BOCKUS (Philadelphia): There is one thing I should like to mention and that is the necessity for keeping the pyloric ulcer segregated from the other types of stomach ulcer. I have had 3 cases which have recently been reported with a sizeable gastric ulcer above the incisure on the lesser curvature associated with marked six-hour gastric retention. In the older textbooks on roentgenology six-hour retention was mentioned as a frequent finding in gastric ulcer without attempting to differentiate between corporic ulcer and ulcer near the pylorus. These 3 cases which have

been reported had a carcinoma at the pylorus accounting for the retention and a gastric ulcer in the body of the stomach. And the thing which led us particularly to suspect the possibility of another lesion accounting for the retention was the fact that the retention did not subside after medical treatment. We have had a number of cases of gastric ulcer of the body of the stomach with gastric retention in which a second lesion was found at the pylorus which proved to be a duodenal ulcer. It is of interest to note that in two of these cases with malignancy at the pylorus the gastric acidity was either normal or hypernormal.

DR. B. R. KIRKLIN (closing): Cases similar to those discussed by Doctor Feldman emphasize a point which I think is extremely important; namely, that it is essential to examine these stomachs with a small amount of barium and with careful manipulation, to approximate the gastric walls during roentgenoscopy.

Doctor Cole mentioned the importance of serial examination, and I heartily agree with him. I am sure Doctor Eusterman feels that if these patients are studied after treatment, and the niche disappears, malignancy can be ruled out definitely.

I think it is only by independent examination by the roentgenologist and by the clinician, especially by the roentgenologist, that we in America have been able to attain such accuracy in the diagnosis of gastric lesions. At the clinic the roentgenologist knows nothing of the clinical story of the patient. We do not want to know the results of the clinical examination until our examination has been completed. Then we want to know all we can find out about them, and to correlate the facts with our roentgenologic data. A member of the roentgenologic staff is present at the operation to see what is found. It was Carman who started this procedure at the clinic, and it was only by careful correlation of all the data that we have been able to attain whatever accuracy we enjoy.

As to the efficacy of belladonna in combating spasm, I feel that reexamination may have more influence than the drug. Often, at the first examination, the patient is frightened by his somber surroundings and the garb of the attendants, and makes all his muscles tense. At the second examination he is more familiar with the environment, is less appre-

hensive, and relaxes more readily. Possibly this plays a larger part than belladonna.

DR. GEORGE B. EUSTERMAN (closing): I think it is a little unfair for the roentgenologist to expect too much of a clinician, especially in those cases seen only in routine consulting-room practice. Of course, it is a good idea for the clinician, if he wishes to improve his diagnostic acumen, to render a tentative opinion after the history has been taken and examination made before the laboratory reports are in. We all realize the difficulty in differentiating between gastric and duodenal ulcers clinically. This can only be done successfully in a small group of cases. The roentgenologist, if he visualizes a lesion, can do it, and so can the surgeon at the operating table, but it is too much to expect of a clinician. He may diagnose ulcer with conviction, but to locate it is another matter. It is not difficult to diagnose the ordinary form of gastric carcinoma in most instances, when one considers the fact that half of these are inoperable at the time we see them. The clinician may

also have evidence that the condition is inoperable although it may appear operable to the roentgenologist.

Regarding the question raised by Doctor Palmer, if I understood him rightly, I think that in some cases we can absolutely say that a lesion of the pylorus is malignant, especially in association with achlorhydria and retention. These differential features are brought out in the paper. It must be remembered that in about 5 per cent of all benign gastric ulcers, usually those of the corpus, a relative achlorhydria may be present and the lesion still be benign. In the absence of surgical exploration and microscopic diagnosis one can only determine the nature of the gastric lesion by the way it behaves under adequate treatment over an adequate period of time, yet Jordan has shown that a considerable percentage of gastric lesions may not fulfill all the requirements of benignancy as the result of treatment and still be benign when removed and examined microscopically.



FACTORS INFLUENCING PROGNOSIS IN THE MEDICAL TREATMENT OF DUODENAL ULCER*

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ALTHOUGH statistics on the results of treatment of duodenal ulcer are difficult to compile and more difficult to interpret, it has been our experience that of all cases treated medically nearly one half, or 46 per cent, may be expected to have one or more recurrences within five years.

Table I indicates that the incidence of recurrences is 9 per cent at the end of the

as successful are definitely known to have had a remission extending over the number of years indicated, we believe that if there is any error in our figures it is towards making the percentage of recurrences too high rather than too low.

Our method of management in all cases reported here has consisted of neutralization methods (Sippy) with the patients in bed in the hospital for about three weeks.

TABLE I
CLINICAL RESULTS IN 392 CASES OF DUODENAL ULCER TREATED MEDICALLY

Duration of Follow Up	One Year	Two Years	Three Years	Four Years	Five Years
Successful cases.....	355 (91%)	211 (81%)	121 (70%)	51 (61%)	20 (54%)
Unsuccessful cases.....	37 (9%)	49 (19%)	51 (30%)	33 (39%)	17 (46%)
Totals.....	392	260	172	84	37

first year and that this incidence increases year by year until at the end of five years only 54 per cent of the patient have had an uninterrupted remission since they were treated.

The lack of any generally accepted standard for what is to be considered a recurrence is one of the difficulties in comparing ulcer statistics and this seemingly high incidence of recurrences in our series is due to the fact that we have classified as cases unsuccessfully controlled all patients with digestive symptoms, apparently due to ulcer which are relatively persistent and severe enough to interfere to any extent with the patient's activity. Many of this group reported themselves as well later. Of course, all frank recurrences of pain, hemorrhage, obstruction and perforations are classified as recurrences. Since the cases recorded

During the hospital treatment the patients are observed carefully and a search made for foci of infection and for other pathological conditions in the abdomen. During part of the following year alternating cream feedings and alkaline powders are given at frequent intervals during the day. The patients are instructed to abstain from tobacco and alcohol and to avoid unusual physical and nervous strain.

Since it is highly desirable to choose a fitting type of treatment for each patient individually, particularly to decide whether medical or surgical treatment is indicated, we have endeavored to determine the factors in the history, physical findings and laboratory data that make it probable that the patient will or will not have a recurrence within five years if he undergoes medical treatment.

* From the Department of Gastro-Enterology, Lahey Clinic. Read before the American Gastro-Enterological Association, Atlantic City, N. J., May 4 and 5, 1931.

With this purpose in mind we have collected 60 cases of duodenal ulcer which have undergone medical treatment in the Lahey Clinic with unsatisfactory results. For the purpose of evaluating certain prognostic points we have subjected the case records of this series to a special analysis and compared them with a series of 60 unselected successfully relieved cases. After the 60 medical failures had been collected it was found that 13 had either deliberately or carelessly failed to follow anything like a satisfactory regime, so that in justice to our statistics we have omitted these from our calculations. (Table II.) The mortality in this series of cases, treated medically, was 0.8 per cent.

TABLE II
CASES OF DUODENAL ULCER SUBJECTED TO COMPARATIVE STUDY

Successful cases.....	60
Cases unsuccessful.....	60
(treatment not followed in 13)	
Because of pain.....	34
Because of hemorrhage.....	13

Gross hemorrhage into the gastrointestinal tract is frequently the chief manifestation of failure in treatment. Certain patients appear to be subject to recurrent hemorrhages without any other symptoms. The clinical aspects of the cases with either mild or no other symptoms except hemorrhages are so different from the type of failure with pain, obstruction, or vomiting, that for the purpose of more careful analysis they have been analyzed separately. Of the 47 medical failures in the series, 13 fall into the classification of failure due to painless hemorrhage. Throughout our comparison of certain clinical and laboratory features we have recorded separately the three following groups: successful cases, cases unsuccessful because of recurrence of pain and cases unsuccessful because of hemorrhage without significant pain or distress.

A history of hematemesis or of the passage of tarry stools was obtained in 15 per cent of our successful cases and in 55 per cent of the unsuccessful cases (Table

III). In the cases which failed because of recurrent pain, 26 per cent gave a history of hemorrhage, while among those which failed because of hemorrhage 77 per cent

TABLE III
THE INFLUENCE OF A HISTORY OF GROSS HEMORRHAGE
ON END RESULTS

	One Hemorrhage	Two or More Hemorrhages
60 successful cases.....	13.4 %	1.6 %
47 cases unsuccessful.....	40.4 %	14.9 %
Because of pain (34).....	23.1 %	2.9 %
Because of hemorrhage (13).....	31.0 %	46.0 %
386 cases of duodenal ulcer.....	15.0 %	4.4 %

	No Hemorrhage	One Hemorrhage	Two or More Hemorrhages
Series of 386 cases followed one to five yrs.....	311	58	17
Successful.....	266 (83 %)	42 (73 %)	3 (18 %)
Unsuccessful.....	45 (17 %)	16 (27 %)	14 (82 %)

had a history of hemorrhage before coming to us. A history of two or more previous hemorrhages was obtained as follows: in successful cases, 1.6 per cent; in cases unsuccessful because of pain, 2.9 per cent; and in cases unsuccessful because of hemorrhage, 46 per cent. In 386 cases of duodenal ulcer, a history of gross hemorrhage was given in 19.4 per cent, including 4.4 per cent who had had two or more hemorrhages. The relatively much higher incidence of hemorrhage, particularly repeated hemorrhages in cases which eventually prove to be unsuccessful, indicates that this point is of considerable prognostic value in estimating the probability of success or failure of medical treatment. The importance of two or more hemorrhages is strikingly brought out when the follow-up reports of cases with this history are compared with the results of cases without such a history. This table shows that in 386 cases of duodenal ulcer, there were 58 cases which gave a history of one hemorrhage. Of these, 16 or 27 per cent experienced a relapse within three

years with a recurrent hemorrhage the cause of failure in 9 cases. Of 17 cases which had had more than one hemorrhage before treatment, fourteen or 82 per cent had a recurrence of symptoms which in 12 of the 14 consisted of hemorrhage.

The symptom of vomiting was recorded as present only when it was an outstanding feature usually associated with gastric retention (Table IV). The fact that vomit-

TABLE IV
VOMITING AND SIX HOUR GASTRIC RESIDUE

	Vomit- ing	6 Hour Gastric Residue
60 successful cases	15%	10%
47 cases unsuccessful	36%	30%
Because of pain (34)	50%	41%
Because of hemorrhage (13)	0%	0%

ing and six-hour retention of barium occur over three times as frequently in unsuccessful as in successful cases, shows that they are indications of the severity of the ulcer.

There is apparently no striking difference in the severity of the pain or its radiation in the successful cases and in

TABLE V
PAIN

	None	Mild	Moder- ate	Severe	Very Severe
60 successful cases	0%	60%	32%	6%	2%
47 cases unsuccessful	4%	49%	34%	11%	2%
Because of pain (34)	0%	38%	44%	14%	3%
Because of hemorrhage (13)	15%	77%	8%	0%	0%

Radiation to Back And Chest

Recorded in	
54 successful cases	37%
45 cases unsuccessful	20%
Because of pain (32)	25%
Because of hemorrhage (13)	8%

Night Pain

Recorded in	
52 successful cases	36%
41 cases unsuccessful	49%
Because of pain (28)	61%
Because of hemorrhage (13)	22%

those which had a recurrence of pain after treatment (Table v). Night pain and distress, however, are almost twice as common in the unsuccessful group. Pain

in the hemorrhage cases is noticeably mild or absent.

At the first physical examination there were few physical findings which proved to be of prognostic importance (Table vi).

TABLE VI
PHYSICAL EXAMINATION
EPIGASTRIC TENDERNESS

Recorded in	
49 successful cases	22%
41 cases unsuccessful	34%
Because of pain (28)	50%
Because of hemorrhage (13)	0%

However, epigastric tenderness was twice as common in the cases which later had a recurrence of pain, as in the successful cases.

The gastric acidity was determined by the titration of the free and total acidity in the gastric contents obtained forty-five minutes after the ingestion of an Ewald test meal (Table vii). The results of the first examination show that the finding of

TABLE VII
GASTRIC ACIDITY

	Free HCl of 60 or over	Free HCl between 40 and 60	Free HCl under 40
60 successful cases	40%	29%	31%
47 cases unsuccessful	36%	49%	15%
Because of pain (34)	41%	41%	18%
Because of hemorrhage (13)	23%	69%	8%

a high, normal, or a low gastric acidity is of little prognostic importance because they occurred in both groups in about the same proportion of cases. In most of the cases the test was repeated every few months during the two years after the treatment was started (Table viii). It was found that in 56 per cent of the successful and in 77 per cent of the unsuccessful cases the acid secretion after a test meal remains the same as it was before treatment. In about 8 per cent of both groups there is even a tendency to an increase in acid secretion. However, in 36 per cent of the successful cases there was a definite tendency towards a decrease in acid secretion as compared to 15 per cent of the

unsuccessful cases showing this tendency before there was a recurrence.

The resistance to neutralization of the gastric contents with alkali therapy was determined by titrating the unneutralized acid one-half hour after the last powder was given at nine P.M. The results showed

the fluoroscopic and film methods (Table x). The activity of the stomach was noted and the deformity of the duodenal cap was classified as slight, moderate, marked and "no filling." The comparative results showed that although hyperperistalsis and the degree of deformity of the duodenal

TABLE VIII
EFFECT OF TREATMENT ON THE HCL RESPONSE TO A TEST MEAL

	Persistently High HCl (Over 50)	Persistently Normal HCl (30-50)	Persistently Low HCl (Under 30)	Decreasing HCl (High to Normal)	Increasing HCl (Normal to High)
59 successful cases.....	24%	30%	2%	36%	8%
39 cases unsuccessful.....	38%	36%	3%	15%	7%
Because of pain (27).....	41%	37%	0%	15%	7%
Because of hemorrhage (12).....	33%	33%	8%	17%	8%

that complete neutralization was not obtained and apparently was unnecessary in one-third of the successful cases. Although the unsuccessful group which later had a recurrence of pain showed a much higher percentage, or 61 per cent, of cases with resistance to neutralization, the feature is not sufficiently characteristic

TABLE IX
NEUTRALIZATION

	Satisfactory Night Neutralization	Unsatisfactory Night Neutralization
Recorded in		
58 successful cases.....	66%	34%
42 cases unsuccessful.....	48%	52%
Because of pain (31).....	39%	61%
Because of hemorrhage (11).....	73%	27%

to make it important in the prognosis of an individual case.

The roentgen-ray examination of the duodenum was done by a combination of

cap are indications of the severity of the ulcer, they are of little value in estimating the success of treatment.

The effect of treatment upon the x-ray appearance of the duodenal cap, however, is strikingly shown by the subsequent x-ray examinations during the two years following the hospital treatment (Table xi). We believe that the disappearance of the duodenal deformity in 70 per cent of the successful cases combined with an improvement of the duodenal outline in 20 per cent more, leaving only 10 per cent unchanged, is of particular significance when compared with 51 per cent with no improvement in the x-ray defect among those who later had a recurrence of pain. The fact that the duodenal defect disappeared in some of the cases which later had a recurrence of symptoms shows that the defect was chiefly spasm which was relieved for a while by treatment although

TABLE X
HYPERPERISTALSIS AND DEFORMITY OF THE DUODENAL BULB

	Hyperper- istalsis	Degree of Deformity of Cap			
		Slight	Moderate	Marked	No Filling
60 successful cases.....	43%	17%	67%	15%	2%
47 cases unsuccessful.....	60%	21%	55%	19%	4%
Because of pain (34).....	71%	12%	59%	23%	6%
Because of hemorrhage (13).....	31%	46%	46%	8%	0%

the underlying disease was still unrelieved. On the other hand, the 10 per cent of successful cases showing no change in the outline of the cap as a result of treatment suggests that in some cases the duodenal

TABLE XI
RADIOLOGIC CHANGES AFTER TREATMENT

	Improve- ment	Disappear- ance	No Change
60 successful cases	20 %	70 %	10 %
43 cases unsuccessful	42 %	16 %	42 %
Because of pain (31)	39 %	10 %	51 %
Because of hemorrhage (12)	50 %	25 %	25 %

defect is, in part at least, due to permanent cicatricial contractions. These results indicate that the repeated x-ray examination is the most useful and reliable single objective check on the progress of treatment.

We found that although gastric retention is four times as common in the unsuccessful cases, its presence does not preclude satisfactory recovery under medical management (Table XII). Even in some of the

TABLE XII
BARIUM RETENTION

	Six Hour Residue	Relieved in Hospital	Not Relieved in Hospital
60 successful cases	10 %	5 %	5 %
47 cases unsuccessful	32 %	17 %	15 %
Because of pain (34)	41 %	26 %	15 %
Because of hemorrhage (13)	8 %	8 %	0 %

cases which still had retention at the end of the hospital treatment, the condition improved and the stomach was found to empty in normal time in subsequent examinations. However, persistent retention was three times more frequent in the cases which later had a recurrence of pain.

Occult blood in the stools was a finding which proved to have some importance in the prognosis of ulcer cases (Table XIII). Slow bleeding into the duodenum is apparently an indication of a severe lesion, particularly if there is a tendency to persist during rest in bed on a neutralizing treatment. There were over four times as many

unsuccessful cases with occult blood as successful cases showing this test.

Alkalosis is a subject of considerable interest since patients are not infrequently encountered who cannot tolerate alkali in

TABLE XIII
OCCULT BLOOD IN STOOLS

	Occult Blood Present on Admission	Persistence for One Week or More on Treatment
59 successful cases	12 %	8 %
46 cases unsuccessful	52 %	28 %
Because of pain (33)	52 %	30 %
Because of hemorrhage (13)	54 %	23 %

the dosage employed in the neutralization form of treatment. (Table XIV.) Thirty per cent is the strikingly high incidence of mild or severe alkalosis shown by these unsuccessful cases as compared with 3 per cent in the successful group and 6 per cent in a large group of ulcer cases treated with alkalis. This confirms the observation that frequently medical failure is caused by the inability of the patient to tolerate sufficient alkali to control his symptoms. We have noted alkalosis rather frequently in a transient form characterized by the onset of the usual symptoms which disappear when alkalis are withdrawn and do not reappear when the powders are resumed in exactly the same dosage. In the second type, which we have designated as mild, the symptoms reappear if the powders are resumed in the regular doses, but the patients are able to tolerate alkalis in somewhat reduced amounts which are frequently found on further observation to be sufficient to control the symptoms. In the severe form no appreciable amount of alkali can be given without the induction of severe symptoms accompanied by nitrogen retention and other marked changes in the blood chemistry. The relatively much higher incidence of alkalosis in the unsuccessful cases indicates that intolerance to alkalis is an unfavorable prognostic sign for the success of medical treatment for ulcer. Of 23 patients who showed definite intolerance to alkalis

and who have been followed for at least a year, 70 per cent had recurrences. (Table xv.)

The prognostic significance of hypertension appears to be related to the intolerance to alkalis because over half of the cases

TABLE XIV
ALKALOSIS

	No Alkalosis	Transient Alkalosis	Mild Alkalosis	Severe Alkalosis
60 successful cases.....	58	0	2 (3%)	0
47 cases unsuccessful.....	31	2 (4%)	8 (17%)	6 (13%)
Because of pain (34).....	21	2 (6%)	5 (15%)	6 (18%)
Because of hemorrhage (13).....	10	0	3 (23%)	0
577 cases of duodenal ulcer.....	529	12 (2%)	20 (3%)	16 (3%)

Although the causative factors and the mechanism by which they produce alkalosis are still largely undetermined, there are

TABLE XV
EFFECT OF ALKALOSIS AND OF HYPERTENSION ON CLINICAL END RESULTS

23 Cases Showing Mild or Severe Alkalosis (followed for one year or longer)	
Successful.....	7 (30%)
Unsuccessful.....	16 (70%)
46 Cases with Hypertension (followed for one year or longer)	
Successful.....	29 (63%)
Unsuccessful.....	17 (37%)

distinct clinical associations between this condition and hypertension, arteriosclerosis and chronic vascular nephritis (Table xvi). In a large group of duodenal

TABLE XVI
HYPERTENSION

	Hypertension	Normal Blood Pressure
59 successful cases.....	5 (9%)	54
43 cases unsuccessful.....	14 (33%)	29
Because of pain (31).....	10 (33%)	21
Because of hemorrhage (12)....	4 (33%)	8
572 cases of duodenal ulcer.....	75 (13%)	497

ulcer patients we found hypertension in 13 per cent, the criteria of hypertension being a systolic pressure of over 150 or a diastolic pressure of over 90. In the group of successful cases studied, the incidence of hypertension was smaller or only 9 per cent, while the unsuccessful cases showed a much higher percentage or 33 per cent.

with either severe or mild alkalosis had elevated blood pressures. (Table xvii.) The relationship between kidney function and intolerance to alkalis is brought out by the fact that out of 36 cases of alkalosis, 9 had elevated non-protein nitrogens in the blood, 5 had other evidences of renal impairment, such as diminished phthalein

TABLE XVII
HYPERTENSION IN 44 CASES WITH ALKALOSIS AND IN 528 CASES WITHOUT ALKALOSIS

	Hypertension	Normal Blood Pressure
Severe alkalosis (14).....	8 (57%)	6
Mild alkalosis (18).....	14 (78%)	4
Transient alkalosis (12).....	4 (33%)	8
No alkalosis (528).....	49 (9%)	479

output and fixation of specific gravity, 5 had obstructive urinary tract disorders, such as unilateral hydronephrosis in 3, and bladder neck obstruction in 2. (Table xviii.)

CONCLUSIONS

In conclusion, therefore, we have found that nearly one-half of all cases of duodenal ulcer treated medically have one or more recurrences within a period of five years after treatment.

About one-fifth of the recurrences can be ascribed to carelessness on the part of the patient.

A little over one-fourth of the remaining recurrences are characterized by gross

hemorrhage which is not associated with pain or other important symptoms.

Among the clinical features which are manifest in the examination and treatment of cases of duodenal ulcer, there are some

tion of barium in the stomach particularly if still present at the end of three weeks' hospital treatment, a history of one gross hemorrhage, a marked resistance to neutralization of the gastric contents with

TABLE XVIII
RENAL FUNCTION IN CASES WITH ALKALOSIS

	Nitrogen Retention	Impaired Renal Function	Obstructive Surgical Lesions	Normal Renal Function
Severe alkalosis (16).	6	3	2	5
Milk alkalosis (20)	3	2	3	12
	—	—	—	—
Total.....	9	5	5	17

with important prognostic significance, others with suggestive but inconclusive prognostic value and others which give no aid whatever in estimating the probability of success or failure of medical treatment. (Table xix.)

alkali therapy, occult blood in the stools particularly if there is a tendency to persist on treatment, and the physical findings of hypertension and epigastric tenderness.

The features which have little or no

TABLE XIX
SUMMARY

Features with Important Prognostic Significance	Features with Suggestive Prognostic Significance	Features with Little or No Prognostic Significance
1. History of one or more gross hemorrhages. 2. Intolerance to alkali therapy.	1. Persistent six hour retention of barium. 2. Failure of duodenal outline to improve after treatment. 3. History of one gross hemorrhage. 4. Resistance to neutralization. 5. Persistent occult blood in stools. 6. Hypertention 7. Epigastric tenderness.	1. Age. 2. Sex. 3. Age at onset of symptoms. 4. Duration of disease. 5. Severity of pain. 6. Degree of deformity of the duodenal cap. 7. Degree of hyperacidity.

The two most important features which are outstanding enough to be useful in planning treatment for the individual case are, first, the history of two or more gross hemorrhages, and second, the demonstration of a marked intolerance to alkali therapy.

Among the features which are characteristically more common in cases who are ultimate failures on medial treatment but are not sufficiently outstanding to make them conclusive indication for or against medical management are: failure of the duodenal cap to show improvement in outline after treatment, the six-hour reten-

tion of barium in the stomach particularly if still present at the end of three weeks' hospital treatment, a history of one gross hemorrhage, a marked resistance to neutralization of the gastric contents with

tion of barium in the stomach particularly if still present at the end of three weeks' hospital treatment, a history of one gross hemorrhage, a marked resistance to neutralization of the gastric contents with

Alkalosis was found to be associated in a large proportion of cases with hypertension, other evidences of chronic vascular nephritis and with obstructive surgical lesions in the urinary tract.

DISCUSSION

DR. JULIUS FRIEDENWALD (Baltimore): In considering the plan of treatment to be instituted in ulcer, the greatest difficulty arises as to the etiology of this affection, which is still obscure. We cannot be content with viewing the disease simply as a local manifestation limited to the stomach or duodenum alone, inasmuch as some systemic disturbance may be largely accountable for the chronicity of the local condition. In a series of 200 of our ulcer cases the following causative factors were noted:

	Per Cent
Infections	42
Disturbances of nervous system	14
Disturbances of endocrine system	4
Hyperchlorhydria	8 5
Trauma	2
Anemia	14
Arteriosclerosis	13
Syphilis	2 5

The etiology of ulcer is therefore extremely complex and it is evident that there may be many causes contributing singly or in combination entering into the production of this affection. In order therefore to secure the best results not only from medical but surgical treatment as well, it is important to determine if possible the presence of all causative factors. It is only in this way that a complete eradication of the disease and a permanent cure can be expected.

In considering the plan of treatment to be instituted in peptic ulcer, one must bear in mind the three clinical types of this disease with which we are confronted, which Crohn has more recently emphasized in his book: the acute form, the recurrent and the chronic continuous type. In the acute type we are usually dealing with younger individuals (rarely beyond forty years) and while the symptoms may be most profound such as hemorrhage, these ulcers show a marked tendency to heal and are usually well controlled by medical treatment. The recurrent ulcers in which there are periods of remission also present periods of healing, even though these be incomplete and scar formation is not perfect. With thorough medical treatment, however, cicatrization may be brought about and permanent healing secured. When this does not occur, chronic ulcers develop, which follow a continuous course without remission and rarely present any

marked evidence of healing. In this type, the symptoms are usually progressive and may simulate carcinoma. The pathological process is usually that of a large callous ulcer. Such ulcers may require surgical interference in order to obtain permanent cure.

While the indications for medical or surgical treatment, therefore, are quite definite in some instances, there are many cases occupying the borderline, in which the correct procedure to be followed may remain uncertain. It is often surprising how a very large proportion of cases of duodenal ulcer yield completely to rigid medical treatment and on this account the patient should always be given, when possible, the benefit of such a cure, especially as there is but slight possibility of malignant transition in duodenal ulcer. There is even a definite though small group of cases in which pyloric stenosis occurs as a result of the cicatrization from ulceration in which the symptoms of retention may disappear and in which the motor function of the stomach may be restored to normal or nearly normal by means of medical treatment alone.

I am equally confident that most gastric ulcers will also heal under medical treatment and inasmuch as the incidence of the transition into malignancy of this affection is but slight (not over 6 to 8 per cent), medical treatment should be undertaken except in the obviously suspicious or doubtful cases.

I am also in thorough accord with Dr. Jordan, not to consider surgery indicated as long as the gastric defect continues to diminish in size and gradually disappears and occult blood remains absent from the stools while the patient is under treatment. If this does not occur, operation is indicated.

Finally, I still remain an ardent advocate of at least three to four weeks of hospital bed rest when treatment is first instituted. This not only assures at least a good beginning in the process of healing, when this is at all possible, but also gives an opportunity to impress the patient with the need of a certain amount of rest and care in diet which of course must be continued for a long period following the bed rest, as an ambulatory form of treatment. In a study by Morrison and myself, we have shown that of 521 cases of ulcer treated by the rest method, many of which were followed up for a long time, there were 70 per cent of recoveries, as compared with 45 per cent of recoveries in

cases treated by the ambulatory method. It has become evident to us that when an ulcer patient is treated medically, he should be thoroughly treated and ambulatory treatment should if possible not be instituted at first. I am well aware of the difficulties and impossibility of carrying out this plan in all instances, but I do believe that one can expect to obtain far more satisfactory results by means of this method than by the ambulatory regime which has at least in our hands proved unsatisfactory in many instances, unless preceded by a reasonable period of bed rest. The main object therefore in advocating the rest treatment is not so much that a few weeks of bed rest will effect a cure in itself, but it will serve as a means of training and demonstrating to the patient himself the need of dietetic care as well as mental and physical relaxation over a long period of time, as a means of accomplishing an effective and permanent cure.

There can be no question but that relapses are frequently due to indiscretions following the cure when the patient is no longer under the physician's control. The patient's diet should therefore be carefully outlined and his habits regulated and when possible he should report at stated intervals for re-examination over a period of a year or more so as to determine the ultimate result of treatment.

DR. MARTIN E. REHFUSS (Philadelphia): I think this is a very timely subject because it seems to fit in with the various reports that have been made before this Society in the past. I do not think we have any quarrel with the reports from Boston. They seem to agree with all the carefully tabulated reports that have been made regarding the medical treatment of ulcers.

But there was a very important thing that I did not hear in the paper and that is what was the mortality in these cases. In other words, presumably there was no mortality and if there was no mortality, then the unsuccessful cases in a sense could be given further treatment.

So far as I am concerned, I have always felt that duodenal ulcer was essentially a chronic disease. There is an acute form undoubtedly but I believe that acute form is rather an acute exacerbation of an underlying chronic lesion.

In going over these cases I have had a fairly large number of cases of duodenal ulcer. About four or five years ago I gathered all together 200 cases. I reported 100 before that. And I

was more and more impressed with the fact that an individual with duodenal ulcer must live differently. We do not cure them in three weeks in the hospital. I realize that because we do a rigid x-ray check-up and because the lesion does not disappear from the duodenal cap. We are all agreed, apparently, that it takes somewhere around six months to two and a half years to cure an ulcer. Therefore the two-year interval is a very good one as an incidence of cure. And yet on the Continent today they are beginning to realize the essential thing in the cure of ulcer is a change in the method of living. In other words, the patient has got to accustom himself to six meals a day; he has got to live differently. You would be surprised to know what this awful catastrophe recently in the stock market has done to duodenal ulcer. The gastro-enterologists have not suffered from lack of work in the last six months I am sure and that work has largely been along this line, showing the tremendous nervous influence in ulceration and its recurrence. In three or four days we can control the symptoms but I believe that the first thing to do with a duodenal ulcer patient is to appraise him of his condition. Teach him a method of living. He ought not to smoke because there does not seem to be among the majority of people such a thing as smoking in moderation, and I can say that from personal experience.

There are two or three things I should like to call attention to:

The question of acidity. In 78 per cent of duodenal ulcer cases there is a high acidity. If we follow out the acidity of duodenal ulcer we will find the one and a half hour or one and a quarter hour point show a different series of figures than we have here.

Furthermore, I do not believe we can take a duodenal ulcer case and use an ordinary stock method. In one group of cases we can neutralize the free acid with calcium; in another with soda, bismuth and magnesia. Why, I cannot tell. But I try in difficult cases to figure out for myself what combination of circumstances will control the free acidity because the free acidity certainly has something to do with continuance of lesions.

Another question: the deformity of the duodenal cap. I believe in gall-bladder work and duodenal work we are getting to the place where we have to have roentgenographic control. The question of deformity I believe is not nearly

as great as the type of deformity. I believe the actual crater of the ulcer can be demonstrated in the cap. I frankly would much rather have a cap grossly deformed than I would one that showed a sharp niche which is more difficult to control. I am always afraid of niche rather than deformity. Furthermore, those of us who do our own fluoroscopy realize the deformity of the duodenal cap takes a long time to disappear. The cap very quickly apparently smooths out in a partial way. But I do think myself it is the best criterion for ulcer healing and I do think it is the best criterion as to the stage of treatment.

Another thing is that duodenal ulcer frequently heals over with stenosis and a partially healed ulceration will frequently be just as definite an indication for surgery in an individual as in a patient who has no success whatsoever so far as symptomatology is concerned, because he is beginning to get gradual stenosis, definite retention, hypersecretory crises and vomiting. Then he will be a surgical risk.

DR. J. L. KANTOR (New York): I want to take just a minute to register a plea for the abolition of the term "peptic ulcer." I think the title "Factors Influencing Prognosis in the Medical Treatment of Peptic Ulcer" could be improved by indicating whether the ulcers discussed are gastric or duodenal or both. In the present stage of our knowledge I think we ought to distinguish between duodenal ulcers and gastric ulcers and even jejunal ulcers. Gastric ulcer is a rather rare disease; duodenal ulcer is very common. Duodenal ulcer occurs in men about nine times as often as in women. Gastric ulcer occurs approximately evenly between the two sexes as far as I know.

DR. L. G. COLE (New York): I wish to congratulate the speakers primarily on the fact that they were discussing one particular lesion; that is, an ulcer beyond the sphincter and were not messing the discussion up with gastric ulcer.

It is evident that the first discussor prepared his paper before he heard their paper, and, therefore, assumed that they were not going to stick to the subject of duodenal ulcer, and he made his remarks evidently as intending to include both pre-pyloric and post-pyloric ulcers. I hope that if nothing else is accomplished by repeatedly harping on this subject before this Society, sooner or later, we may learn to discuss one or the other of the regions, I do not care

which, and not attempt to discuss both at once, or apply the findings of one region to the problems of the other.

On the question of cap deformity and crater deformity, there is a great controversy as to which is of greater value. There is no question, however, but that a cap deformity is the essential factor which determines whether a patient has or has not an ulcer, because Akerlund, who is most enthusiastic about the diagnosis being based on the crater, finds craters in only from 60 to 75 per cent of the cases. How about the other 40 per cent, if one is depending upon the crater?

The crater deformity is a certain type of ulcer, an acute ulcer that a patient did not have when he went to bed at night but wakes up at five o'clock this morning with an ulcer and when he comes downstairs at nine o'clock, four hours after onset of symptoms, one can see that ulcer, and see it by the evidence of the crater. I would one hundred times rather have that type of crater than to have a cap deformity such as Dr. Rehfuess spoke about. So there are certain types of cap craters that are relatively no more significant than a canker in a person's mouth. The thick deep turbid crater with a rather deep hole, with a heavy ridge that is there day after day and week after week and month after month, is a more serious type of ulcer. And even that has a tendency to heal completely but its ability to heal completely and stay healed is very slight. Therefore, if one can observe that crater from time to time and see that it is diminishing and flattening, this observation becomes a valuable criterion in determining whether it is healing and the rapidity of the process of repair.

I am not nearly as enthusiastic about the disappearance of the cap deformity being a factor as perhaps some others are.

I think that when one sees a real cap deformity the patient is pretty likely to carry it to the grave, but it may not hasten the trip.

I should like to say, as to the results of medical and surgical treatment, gastric ulcers heal and stay healed, although others may form. The ulcer beyond the sphincter is a totally different thing. They are much less likely to heal and either they or cousins or brothers or sisters develop afterward to an extent of 46 per cent. I hope that we are going to find that other 4 per cent because for some period of time I have said, when I have been

asked "Do you think a postpyloric or cap ulcer ought to be treated surgically or medically?" I have said, "You are damned if you do and you are damned if you don't," meaning that the prognosis was equally bad with or without surgery. I hope that we may find the other 4 per cent to bring the evidence up to that fifty-fifty to justify my prophecy of a fifty-fifty chance for recovery.

DR. BURRILL CROHN (New York): I wanted to ask Dr. Jordan whether she takes into consideration the factor of the incidence of infection, head colds, tonsillitis, other respiratory infections as causing recurrence of ulcer. In our experience it is a very important factor in initiating recurrence. I should like to ask Dr. Jordan whether she made any studies of cigarette smoking or smoking in general upon incidence of ulcer and causes of recurrence.

DR. SARA M. JORDAN (Closing): I want first to explain the discrepancy between the figures which appear in the abstract in the program and the paper which we actually presented. We had a series of 851 cases of ulcer which we intended to review here as we did these cases of duodenal ulcer but we found that 66 of them had been treated with ambulatory measures (with some reluctance on our part) and we therefore did not include them in this series. Two hundred and sixty-six had not been sufficiently well followed. Eighty-four were gastric lesions and we did not wish to mess up this paper, as Dr. Cole said, with the gastric ulcer cases because we feel that although they may be identical in etiology, they certainly are a distinct form which requires a different form of treatment. Forty-three were gastrojejunal and those also fell into the class which we felt should be considered separately.

With regard to the evaluation of the results, only a few of this 46 per cent came to surgery. Many of them had one recurrence during a period of three or four or five years which lasted perhaps a week or perhaps two weeks, but the symptoms of which were so definitely felt by the patient to be the same as his original symptoms that we included them in this group showing a recurrence.

Another difficulty as we all notice I am sure in evaluating ulcer results is the fact that just when we have our group of good cases and bad cases assorted, one of the good cases may perforate or two or three of the unknown cases, hidden cases which we have not heard from for two or three years possibly because of some embarrassment due to their financial relations with us, will suddenly appear again and say they have been perfectly well during that time. So that both ways the statistics are changed even after they are compiled.

The purpose of the study was to give us some idea as to what to tell the patient when as Dr. Cole says the patient comes and asks: what shall we do with this duodenal ulcer? Will it be treated medically or surgically? We feel that now perhaps we have a little better foundation upon which to base a statement as to the prognosis. We also feel that we may perhaps in some of these cases treat them with a combined treatment, medical and surgical.

I wish to tell Dr. Rehfuess that 0.8 per cent of the patients die with medical treatment.

Dr. Cole we also got together the surgical results of a group of cases and found that in five years 48 per cent of them came back or had a recurrence during that time so that the figures stand about equal: 46 per cent medical and 48 per cent surgical.

The deformity of the bulb I think perhaps needs a little more careful study. In our cases we have not been able to distinguish between the two types of penetrating lesion. But that penetrating type of defect was found equally often in the unsuccessful and successful group.

Regarding smoking, I always tell patients that it is my impression that we can divide our successful and unsuccessful cases into those who do smoke and those who do not. That is perhaps exaggerated but smoking does play a very large part in recurrence.

In regard to infections, we do see a relationship between injections and recurrence of ulcer symptoms, but I cannot give you the statistics. The effect of an acute attack of influenza or sinus or other respiratory infections is often seen in conjunction with a recurrence.



DIARRHEA OF UNKNOWN ORIGIN*

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IN these days of scientific medicine, it is remarkable that even the specialist who has every means of diagnosis at his command must still stand puzzled before most of his cases of diarrhea. My impression gained from reviewing records in The Mayo Clinic for 1930 was that in more than two-thirds of the cases in which diarrhea was the major complaint, there was nothing definite to explain the condition.

In order to analyze more carefully the data in this large group of cases, I reviewed the records of 100 cases of diarrhea in which the cause was indeterminate. Fortunately in some instances, the patients returned for observation, at which time it was possible to make a more positive diagnosis. Most of the patients had had treatment elsewhere for so-called colitis. The feeling at the Clinic is that the suffix "itis" should refer to inflammation and therefore the term colitis should be reserved for those cases in which actual inflammation of the colon can be demonstrated by the roentgenogram or by sigmoidoscopic examination.

In the series of 100 cases, specimens of the stools had been examined by experts for intestinal parasites and cysts; in some instances bacteriologic studies were made for *Bacillus dysenteriae* and other pathogenic organisms. Sigmoidoscopic and roentgenographic observations were made in each case. In 88 per cent of the cases, the gastric acids were tested. In every case, general examination was made to rule out systemic diseases, such as tuberculosis and hyperthyroidism. Few of these patients had lived in the tropics. Several had been treated for amebiasis. Parasites of some type were present in the stools of 31 cases. Two and often five or more stool exami-

nations were made in almost every case. The parasites identified were: *Endamoeba coli* in 11 cases; *Endolimax nana* in 7 cases; *Giardia lamblia* in 5 cases; *Chilomastix mesnili* or *Trichomonas hominis* in 7 cases; *Endamoeba histolytica* in 2 cases, and *Embadomonas intestinalis* in one case. It might be assumed that *Giardia lamblia*, and certainly *Endamoeba histolytica*, were the causes of diarrhea in these particular cases were it not for the fact that when the parasites were removed by proper treatment, there was no improvement of the diarrhea. Obviously it is possible for persons to harbor intestinal parasites which have nothing to do with their diseases and which apparently are commensals; they may be likened to fleas, which are parasites to be sure and well worth removing, but not the cause of the symptoms. I find it difficult to agree with the statement that in a high percentage of cases^{1,4} intestinal parasites may be suspected from the history. In 31 cases of the series in which the intestinal parasites did not play a part in causing the diarrhea, the histories were not different from the remainder of the cases in the series.

The general condition of the entire group of patients may be thought of as varying from the extreme of no general impairment to that of the need for immediate hospitalization. The ratio of males to females is 1:1.3, somewhat above the 1:1.1 ratio for all patients in the clinic. The ages varied from nineteen to seventy-five years, about two-thirds of the cases occurred in the decades from thirty to fifty years. The diarrhea had lasted for a few months to as long as thirty years in several cases. The diarrhea was constant in 37 per cent and intermittent in 63 per cent. The stools

* Read before the American Gastro-Enterologic Association, Atlantic City, N. J., May 4 to 5, 1931.

usually were watery, light in color and occasionally were frothy; they contained varying amounts of mucus, but no blood except that which came from the anus. Stools occurred chiefly during the day, perhaps more in the morning hours. Stools at night were not uncommon and occurred even in one case of diarrhea of neurogenic origin. The loss of weight varied from slight to almost half of the patient's original weight. In a few cases, there was no loss of weight and in some cases there was a slight gain. It is interesting to note that diarrhea may persist for months or years without demonstrable evidence of impairment other than the annoyance of frequent stools.

The treatment elsewhere in these cases was extremely varied; the two most striking procedures were the diet and irrigation of the colon. In some cases dietary restrictions were self-imposed, but usually they were prescribed. Often food essentials were deficient, especially protein. Meat seemed to be considered injurious, just as it has been in many other diseases. Not infrequently bran had been used, as well as other well-advertised preparations. Irrigation of the colon with various solutions had been done in many cases, perhaps with no particular injury in some cases but in others it was a definite factor in causing the continuance of the diarrhea. In no case was it apparent that persistent irrigation of the colon had helped to correct the trouble. Last year at the meeting of this Association, Friedenwald and Feldman reported their unfavorable results from irrigating the colon of the dog; I am inclined to believe that the colon of the human being is equally rebellious to such treatment. Seven patients had previously undergone appendectomy in the hope that it would cure the diarrhea. Two patients had had cholecystectomy and one patient an exploration on the possibility of tuberculosis of the bowel. None was benefited. When definite attacks of appendicitis or cholecystitis occur followed by diarrhea, it is reasonable to assume that there is a cause and an effect, and of course in this

type of case operative procedures are justifiable.

For purposes of diagnosis and treatment, I attempted to group these patients according to their symptoms, physical conditions, and often according to their response to treatment. The attempt was discouraging, as each review of the data resulted in rearrangement. I do not feel, therefore, that the following groupings are definite but they serve as a basis on which to conduct further studies.

Neurogenic Diarrhea. In the 4 cases in this group there was no organic cause found for the diarrhea and in each case the disturbance of the bowel was definitely related to emotional strain. One patient had had attacks of diarrhea which occurred only between midnight and 1:00 A.M. Two patients had had diarrhea only during the day; another patient had had diarrhea both day and night. One patient had lost 30 pounds in weight; this was definitely related to insufficient food which the patient hoped might control the diarrhea. In such cases, one must not state too positively to the patient that nothing is wrong. A diagnosis of nervous diarrhea cannot always be easily made with any degree of certainty.

Reflex Diarrhea. In this group of 6 cases an attempt has been made to classify the type of diarrhea which is associated with symptoms of the bowel that are secondary to disease or dysfunction of some other organ. Diarrhea may be merely a symptom of disease elsewhere in the body, for the intestine is an organ of excretion as well as of absorption. In 3 cases the diarrhea followed attacks of abdominal pain suggestive of appendicitis or of cholecystitis. The removal in the clinic of these organs in 2 cases, the appendix in one case and gallbladder in the other, cured the diarrhea. One patient was advised to have cholecystectomy but refused and reported a year later that she still had diarrhea. The cardiorenal system was seriously impaired in one case, and as that improved the diarrhea improved, although diarrhea was

the patient's chief complaint on admission. One patient was relieved elsewhere of the diarrhea by removal of a remaining ovary and the uterus after medical measures at the clinic had been unavailing. The sixth patient had had diarrhea during her first pregnancy and thereafter had diarrhea with each menstrual period and occasionally between periods; this is certainly suggestive of stimulation of the bowel by the pelvic organs. Only one case of this type was noted in the series of 100 cases, but it is not uncommon to see diarrhea associated with normal menstruation.

Irritable Bowel. I am using the term irritable bowel only in cases in which the function of the bowel was irregular and apparently independent of any disease process. There were 31 cases in this group. There was no striking dietary deficiency although the diets tried had been numerous and varied. The results of examinations were within normal limits with the exception that in 7 there was an average loss of weight of 25 pounds which, however, was definitely related to faulty diets. Nineteen of the patients were men and 12 were women. Most of the patients were aged from thirty to fifty years and had been troubled with the diarrhea from one to thirty years, the majority from one to five years. Eight patients had had mild to moderately steady diarrhea, 12 had had diarrhea alternating with normal stools, and 11 had had diarrhea alternating with constipation. The factor of nervousness was usually present and yet this factor was by no means as clear-cut as in neurogenic diarrhea. The patients were not, as a whole, seriously ill, but the diarrhea interfered with their work and pleasure.

Allergic Type of Diarrhea. Most of the 18 patients in this group gave a history of some type of allergy, either direct or indirect. By indirect I mean migraine, urticaria, and hay fever. By direct, I refer to diarrhea occurring following the use of milk, chocolate, clams, buckwheat, more than 10 per cent carbohydrates, pork, carrots, corn, cabbage, fats and beans. In one

instance, diarrhea culminated in an epileptic attack, and with the control of the epilepsy the diarrhea improved. Thirteen patients were women and 5 were men. Fifteen of them had had intermittent diarrhea which had lasted on an average of three to four years. The stools were usually watery with more or less mucus; 3 of the patients had diarrhea also at night. In 2 cases free hydrochloric acid was not present and its administration did not benefit the patient. Such patients were seldom anemic. Six of the group had lost an average of about 15 pounds in weight. Skin tests were disappointing in almost all instances in which they were tried. One woman who knew she was sensitive to buckwheat gave a definite skin reaction to buckwheat.

A diagnosis was made of nervous exhaustion or neurosis in many cases, which is in accord with the general feeling that most allergic phenomena occur in cases in which the patients have a hypersensitive nervous system.

Diarrhea Following Acute Infection of Unknown or Uncertain Etiology. The 7 patients in this group had suffered from acute disturbance of the bowel coincident with respiratory infection, acute tonsillitis, or acute gastrointestinal disorders, from which the diarrhea dated. It could not be determined whether the diarrhea was due to the original organism or whether the infection depleted the patient's reserve and the diarrhea developed. In all cases the diarrhea had been steady and of varying intensity. It continued for three months to eleven years after the appearance of the acute febrile disease. Striking laboratory data were absent in all cases and in only one case was loss of weight permanent, although weight was lost and gained by the others, according to the activity of the diarrhea. It is possible that culture of the stool along the lines suggested by Castellani might have proved enlightening. The stools were usually watery, with some mucus; in one case they were frothy.

Deficiency Diarrhea. In this group of 19 cases the contributing cause of the diar-

rhea, and in some instances the original cause, seemed to be due to deficient diet. Eleven of the patients were women and 8 were men; the average age was between thirty and forty. The diarrhea developed gradually and had persisted for six to twenty-five years with an average of slightly more than six years. The diarrhea was steady in 8 cases, and intermittent in 11 cases. The stools were watery, occasionally green and frothy, and tended to occur more often in the morning, often beginning at 4:00 A.M. and continuing until noon. Among the peculiar eating habits it was noted that the patient: (1) had lived on boiled milk for months because of stomach trouble; (2) had eaten very little because he was afraid food would increase the diarrhea; (3) did not like meats, fresh fruits, or fresh vegetables; (4) lived on soft foods to decrease weight; (5) acquired the habit of eating little but shredded wheat; (6) limited the dietary on his own initiative because of diabetes; (7) lived chiefly on coffee, bread and butter; (8) ate mostly white bread and beans, or (9) dieted to relieve arthritis, and so forth. In some cases striking dietary deficiency was not recorded but in these cases there was a history of long and careful dieting to control diarrhea. Loss of weight was a constant observation and varied from about 10 to as high as 80 pounds with an average of about 25 pounds. Secondary anemia was present; in some cases the hemoglobin was as low as 43 per cent. The illness of the patient depended on the extent of dietary deficiency as well as on the duration of the deficiency. In 13 cases free hydrochloric acid was not found by test meal, and the administration of hydrochloric acid seemed to be a contributing factor in controlling the diarrhea in 3 of the cases. In 3 other cases hydrochloric acid increased the diarrhea. The results of general examination were negative except for loss of weight.

Sprue-type of Diarrhea. Several of the 13 patients in this group were so ill on admission that they were placed in the hospital at once. One patient came from

Texas; the remainder were from the north temperate zone. Diarrhea had persisted from one and a half to thirty years, although in the majority of cases it had persisted about five years. The ages ranged from twenty-one to seventy-five years; the majority of patients were aged from twenty to forty years. As in other groups, the diarrhea was either steady or intermittent. The stools were watery, often large and bulky, grayish, and occasionally frothy. Loss of weight of from 10 to 50 pounds occurred in all but 3 cases. A secondary type of anemia was the rule; the hemoglobin was about 50 per cent. In one case, the blood picture was similar to that of pernicious anemia. The case had been diagnosed as such elsewhere, although free hydrochloric acid was present. Repeated transfusions of blood had been of little value. The tongue was usually red and somewhat atrophic, and stomatitis was common. Several patients complained of cramps in the legs and feet. In one case *Endamoeba histolytica* was identified but antiamebic treatment did not benefit the diarrhea, although the parasite had been destroyed. In 6 cases free hydrochloric acid was absent but in only one case did its administration seem to help control the diarrhea. In both the preceding group and this group further observation may show new symptoms and lead to a different diagnosis, such as pernicious anemia.

Faulty Fat Digestion. There were 2 cases in this group. The stools were grayish-yellow, frothy, and contained macroscopic fat. One patient had lost 10 pounds, and the other had lost 60; however, their general condition was good. Diet had been adequate, although restricted at times. There was only slight anemia. Hydrochloric acid was absent in one case and its administration did not help the diarrhea. Thaysen recently reported on the problem of pancreatic diarrhea, in which he emphasized three observations on which to base a diagnosis: azotorrhea, steatorrhea, and alimentary glycosuria. Because I know of no satisfactory method for determining

pancreatic function, and because of the fact that all but complete obstruction of the pancreatic duct occurs in inflammatory or malignant disease of the head of the pancreas without diarrhea being a constant symptom, I prefer to use the term faulty fat digestion rather than pancreatic diarrhea. Although the patients in this group were not studied along these lines, yet alimentary glycosuria was not present on ordinary diet. Fat was present in the stools but the content of nitrogen in the stool was not tested.

COMMENT

Following a carefully taken history and general examination, it is the procedure in the clinic to make series of examinations of the stools on two or preferably three successive days. Experience is necessary in making the sigmoidoscopic examination in order not to diagnose proctosigmoiditis or ulceration when changes are the result of irrigations or injury from the enema tip. The roentgenogram of the colon by the barium enema is much the better means of obtaining data as to the status of the colon. Exception must be made with regard to the six-hour film for the ileocecal coil, following barium by mouth. The roentgenogram of the colon does not appear to give any positive evidence in this group. I am often asked about the significance of diverticulosis of the colon in relation to diarrhea. I believe that it seldom, if ever, plays a part. Rankin and Brown reported an incidence of 11 per cent of diarrhea in association with diverticulitis. It was not true diarrhea but usually more of rectal tenesmus with the rather frequent passages of mucus, pus and feces, due to the inflammation of the sigmoid.

A test meal is of importance in many cases. In this series of 100 cases a test meal had been given in 88. Free hydrochloric acid was present in 61. Five of the patients had been given acid without benefit; it was given to two others who thought it had helped. Of the 27 who did not have free hydrochloric acid, 6 were benefited by the

use of acid; 5 of these had the steady type of diarrhea. Seventeen did not derive benefit; the effect of the acid on 4 was not recorded. This group of only 6 of 23 patients without acid who were helped by the administration of acid is too small to be of significance. In control series studied by Magath and Brown, only 10 of a group of 100 patients with achlorhydria had diarrhea of unknown origin and even in these 10 it is unlikely that all would have been benefited by acid. Emery recently reported a similar study on the low incidence of achlorhydria as a factor in diarrhea. I agree with his impression, that even when patients are benefited by hydrochloric acid, there is probably some other factor present; the low acid is merely a part of the syndrome.

The tests of skin sensitization must be considered and especially should be tried in the allergic type of diarrhea. My experience with these tests has been limited and the results as a whole have been discouraging. In all but an occasional case of allergy, the patient offered the clue to the sensitive foods. It is to be hoped that refinements of technique in this field will be evolved.

Further studies, such as a cholecystogram, roentgenograms of the stomach, investigation of foci, the metabolic rate, and so forth, are necessary in some cases.

TREATMENT

The diet is so often a contributing factor in increasing or even producing the diarrhea, and proper food is so essential to cure these patients that I shall consider diet first.

In cases of acute exacerbations or of acute diarrhea of indeterminate origin, care should be taken not to add to the patient's difficulties. In most cases the patient can get along a day or two without food, if sufficient fluids are given. Hypodermoclysis or intravenous solutions may be resorted to if necessary. Occasionally it may be advisable to clean out the bowel

with a small dose of castor oil or a saline laxative, but as a rule in these acute cases the intestinal tract has been fairly well cleaned out and a laxative adds insult to injury. After the first day or two, food should be added slowly and be of a simple, low-residue type, such as boiled rice with cream or butter, broths, crisp toast, and tea or coffee. I do not believe that boiled milk is of value in these cases. Childrey and Alvarez showed, experimentally, that milk alone is a high-residue food. The "boiled milk and bismuth" order for acute diarrhea is time-honored, and is perhaps continued from custom more than from satisfactory results.

Moro recently reported satisfactory results in the treatment of acute diarrhea of childhood by the administration of 100 to 300 gm. three times daily of the pulp of raw apples; absolutely nothing else is given for two days. This method might prove of value for adults, although I have not tried it.

A well-assorted, adequate diet, administered as rapidly as is consistent with the patient's tolerance, is the goal to be achieved for chronic diarrhea of unknown origin. It is, of course, impossible to prescribe a diet which is suitable in all cases. Far more harm is done by a too limited diet than by one too free. Many patients have been on such a restricted diet that it is absurd to think they can take care of much food at first. They must be encouraged and must not be allowed to feel that food will cause their trouble to continue. At the onset the patient may fear to eat because of former restrictions and the fear that disastrous results may ensue. One woman insisted that she could not take milk but she had no trouble with cream and milk on cereal. Another woman assured me that she could not eat toast, but could eat zwieback. Still another could not eat fruits or vegetables because of the roughage, yet had been on a diet consisting chiefly of bran cereals. One woman had been convinced that proteins and carbohydrates could not be eaten at the same

time for fear the mixture would explode, yet milk had been her chief diet.

In the beginning, I suggest a low-residue diet which includes 60 to 120 gm. of meat, 15 c.c. of purée of vegetables in a milk soup, and also a meat soup with purée of vegetables. An effort is made to incorporate as many foods as seem to agree in this primary diet. The foods are gradually increased, adding slowly the stewed fruits and vegetables. Finally, raw fruits and vegetables may be added. Individual variations are, of course, necessary, especially in the presence of allergy. Occasionally it is necessary to supplement the diet with proprietary concentrates of vitamins B and D.

If digestion of fat is faulty, the diet best tolerated is usually low in fat, fairly high in protein, and rich in carbohydrate.

In cases of sprue, raw liver or its equivalent is included and gradually decreased as the patient improves. For these patients, the carbohydrates must usually be kept low as their tolerance to it is poor. One patient had a rather long siege on a diet of protein and orange juice but is finally on a full normal diet.

It would be wiser in many cases for patients to be more matter of fact about their food and less introspective.

Irrigations of the colon as a routine have little if any place in the treatment of diarrhea. The occasional use of a small, warm saline enema, preferably at bedtime, may be of aid, but its constant usage is not advisable. If the bowel is irritable, especially if diarrhea alternates with constipation, small oil retention enemas may be used temporarily.

Drugs are of uncertain value. I question the value of inert powders, as they seem in many cases merely to add to the material which must be excreted. Tincture of belladonna is also of doubtful value. In occasional cases a dramatic response may result from the use of 6 grains of emetin hydrochloride hypodermically, but in such a case I think the result must be ascribed to the specific action of emetin on an undis-

covered infection by *Endamoeba histolytica*. In the types of diarrhea considered in this paper, emetin has no effect. Organic arsenicals, as treparsol, may be worthy of trial and infrequently seem to be beneficial. The benefit is probably on a nonspecific basis.

A new product that may prove of value in some cases is 2-4-dihydroxyphenyl n-heptane (dihydranol).⁸ I have tried it in the postinfectious type of diarrhea and it seemed to be of value in 2 cases. In the sprue-type of diarrhea and to a less extent in the allergic type, calcium lactate in large doses over a long period has seemed useful. In some instances, I have used it with parathyroid medication. The beneficial rôle of calcium is hard to explain. It may be along the lines suggested by Scott, who thinks parathyroid dysfunction occurs, or on the basis of altered intestinal permeability of calcium absorption and excretion, according to Snell and Habein. Tincture of iodine by mouth in doses of 10 drops after meals, well diluted, has occasionally helped and is worth bearing in mind.

Vaccine treatment in irritable and allergic conditions of the bowel has received considerable impetus by the work of Dorst and Morris. During the last year, 6 patients have been treated according to this method. An adequate diet was outlined and nonspecific drugs were usually included, such as iron citrate for the anemia and calcium lactate. Soricin, orally, was included with the vaccine treatment. In 2 cases I felt that this method had proved beneficial. In the other 4 cases in which it was used it did not seem to be beneficial. Treatment along these lines will be carried out in other cases.

In 3 cases a fairly long trial had been made elsewhere than in the clinic of vaccine prepared from an organism isolated from the patients' stools. In none was benefit obtained. In each case the incorrect diagnosis had been made of chronic ulcerative colitis and the reported isolation of Barger's diplococcus. In 3 cases in the clinic stock vaccine of chronic ulcerative colitis

was administered. In one case it was administered because the diarrhea followed tonsillectomy and it was thought that a possible focal relationship might exist, as in true ulcerative colitis; in the other 2 cases, the patients insisted on receiving this vaccine. In none of the 3 cases was the vaccine of benefit. This observation is in distinct contrast to the results obtained in ulcerative colitis in which response to specific serum and vaccine is usually definite.

My preliminary impression is not especially favorable to treatment by vaccine in most cases of indeterminate diarrhea. McCarrison's experimental work may be applied to human beings in that inadequate or deficient diet can so lower the functional perfection of the gastrointestinal tract as to impair its natural immunity to the customary organisms of the colon. Whether treatment by vaccine is the approach to restoring this resistance is a matter to be determined.

SUMMARY

A study of the treatment and diagnosis of diarrhea of indeterminate origin shows that much work remains to be done. The term colitis should be reserved solely for conditions in which there is demonstrable inflammation of the colon. At present, the term has come to be indiscriminately used and often is productive of much mental distress to patients. The types of diarrhea considered here were those occurring in this particular series of cases. Further work may decide that such groups as the faulty digestion of fat, deficiency diarrhea, and sprue may be in one large group.

Suggestions are made for the treatment of acute diarrhea, especially the type which occurs postoperatively or in conjunction with intercurrent respiratory infection.

The word diet is objectionable in view of so many widespread eccentric articles and advertisements that are now existent. The patient should be impressed with the importance of proper and adequate foods.

As a routine, colonic irrigations are condemned.

Treatment by vaccine in certain types of indeterminate diarrhea may prove of value. Further work must yet be done on this phase of the problem.

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DISCUSSION

DR. J. L. KANTOR (New York): If I understood Dr. Brown correctly, he made the point that the best way to study these cases roentgenologically was by the barium enema. The chief objection to studying the colon with the enema alone is that it is an unphysiologic procedure.

I think I showed before this society that a film taken nine hours after the administration

of a barium meal gives much more information about the irritability of the intestine than the enema. So I would suggest again that that method be employed. It is simple, and can be easily incorporated in any routine.

To come back to the enema, the best way in which the enema can give information in early cases is to measure the amount necessary to fill to the ileocecal valve in a given case, and check it against a standard amount required to fill the normal colon. This gives an idea of the degree of irritability of the colon under study; otherwise you have to wait for the gross changes in outline that have been so well described by Carman and Moore in the very advanced cases.

DR. GEORGE B. EUSTERMAN (Rochester, Minn.): I do not imagine that there is any other condition confronting the gastro-enterologist which is so often puzzling as an obscure form of diarrhea. With respect to Doctor Kantor's remarks I will say that he is very familiar with the advantages of the progress meal as regards functional disease of the intestinal tract, but I feel quite strongly, and this feeling is shared by my roentgenologic colleagues, that deviations from the normal, even though slight, are best seen in the barium-filled colon. Probably from the standpoint of function the progress meal gives more information, in the hands of the experienced observer, but from the standpoint of detection of morphologic change we prefer the other method. As gastro-enterologists, we should be mindful of the rôle that allergy plays in the production of gastrointestinal disturbances, and particularly those of the colon. Experience has taught us to be mindful of the rôle of protein hypersensitivity in every case of persistent gastrointestinal disturbance, especially in the absence of demonstrable disease or infection. It is important that the surgeon be as cognizant of this fact as the internist, in order to avoid an unnecessary operation. This is illustrated by a recent experience of an eminent eye and ear surgeon who had run the gamut of American and European clinicians and hospitals trying to get relief from an intractable diarrhea. As the attack followed a severe emotional upset the condition was attributed to a psychoneurotic state, in the absence of other findings. However, a long period of rest failed to bring relief. Examination revealed the presence of several food proteins as direct

causative factors and with their removal from his diet there was a striking recovery within thirty-six hours. The patient has continued to remain well for the past three months. Apparently the emotional upset in this case, like pregnancies and other conditions in other cases, precipitated the allergic tendency.

DR. WALTER C. ALVAREZ (Rochester, Minn.). Certainly it is a brave man who is willing to admit that he cannot make a diagnosis in 3 out of 4 of the cases which he sees, and I wish to congratulate Doctor Brown on his courage and his honesty. I am delighted to hear this paper because many years ago I became impressed with my inability to learn anything about the cause of diarrhea in most of the cases seen. My only consolation was derived from Richard Cabot's confession of ignorance in his chapter on diarrhea in "Diagnostic Clinics."

I was particularly impressed by the fact that even the necropsies that I had performed in a few fatal cases of unexplained diarrhea failed to throw much or any light on the cause. I remember in one case there were scores of enlarged lymph nodes throughout the abdomen, but cultures were negative and the histologic study threw no light on the nature of the infection. In another case we found a roundworm encysted in the wall of the duodenum, possibly irritating it and keeping up the intense peristalsis. In another patient no cause could be found.

It is a curious fact that a number of patients with unexplained diarrhea have suffered with it for many years and yet have not lost weight and have not become seriously ill. I know one woman who has had as many as twenty bowel movements a day for ten years or more, and when last I saw her she was somewhat overweight and still able to keep at work. One can always, in these cases, take refuge in the thought that the diarrhea is of nervous origin, but that does not help us much.

Sometimes there is also a hereditary factor, or the patient has always had a tendency to loose bowels. I recently saw a man who confessed to me that any unusual strain brought on diarrhea, much as it did in his father. A day or two later I saw his brother who showed the same syndrome.

Another curious thing about these patients is that often their diarrhea is not much in-

fluenced either by the type of food eaten or the type of treatment administered. I have seen them take large doses of medicine, which ordinarily would put a stop to diarrhea, and yet they did not improve. In some cases of course, there may be present an enteritis of the small bowel. As yet it is almost impossible with any of our diagnostic measures to learn much about the condition of the mucous membrane in that *terra incognita* which lies between the third portion of the duodenum and the ileocecal sphincter.

One can think of disturbances of absorption; but unfortunately, we know almost nothing about the normal functions of absorption. The work of Hosoi and Childrey, done under my direction in Doctor Mann's Laboratory, indicates that there are striking disturbances of absorption at times, due to the giving of certain foods. For instance, when we gave cheese to a dog he not only did not digest properly on that day, but for twenty-four or forty-eight hours afterward his powers of absorption were affected deleteriously.

It is possible also that at times the disturbance may be due to the removal of normal inhibition. Thus, if in rabbits one cuts the vagus or splanchnic nerves, or both sets, the animal commonly dies of diarrhea and inanition. The nerves seem to serve as "brakes" for the bowel.

There may also be disturbances in the water-absorbing power of the colon. I can remember a girl who was troubled with one of these long-continued, harmless diarrheas, and in whom it could be seen with the x-ray that the feces solidified normally in the transverse and descending colon. The curious fact was that when the solid feces reached the sigmoid flexure and the rectum they began to liquify again. Something seemed to have gone wrong with the mucous membrane of the rectum which caused it to excrete water into the bowel.

In some of these cases of unexplained diarrhea one can work a spectacular cure by injecting hypodermically a little typhoid vaccine. Fortunately, it seems to work best in just those cases in which nothing else will give relief. In other cases it is well, even when one cannot find amebae, to give a course of twelve tablets of treparsol. If there is no improvement, one can then be fairly certain that the diarrhea is not amebic in origin.

DR. T. R. BROWN (Baltimore): I agree with Dr. Brown in regard to the question of the unreliability of skin tests. Blackfor and I quite independently a few years ago carried out a long series of skin tests by the older methods, and we both came quite independently to the conclusion that in regard to picking out diets it was disappointing although, it was rather helpful in a certain group of cases in which the troubles were associated with various skin manifestations, eczema, erythema, urticaria.

I do think perhaps not enough stress has been laid on psychogenic and neurogenic factors in these cases and quite a few cases that have their origin in shock or nervous upset. We often think of the habit of constipation; we never think of the habit of diarrhea. Perhaps we ought to think of it in the same category. When we see how many people without structural change develop chronic constipation, is it not conceivable that quite the same thing may occur in regard to diarrhea in which we may have disturbance of this delicate balance for controlling peristalsis which spells healthy or normal evacuation. Is it not true that a certain number of cases represent the same habit factor which had its origin in something past, of which the habit has never been broken by appropriate treatment?

In one group of cases, so-called deficient fat cases, sprue-like cases, I have been helped by pancreatic studies. I think determinations from stool studies are more accurate if properly done with extreme, meticulous care. I think the cases are excessively interesting.

Last of all I want to call attention to the fact a number of cases are unquestionably missed because of the fact there is trouble in finding the causative factor. It is surprising how many cases come to autopsy in which the *Endamoeba histolytica* had not been discovered but was found then.

I have had 2 cases recently. One patient had no history of previous dysentery, had gone through several diagnostic clinics and was regarded as a case of nervous diarrhea. And yet finally the parasite was found and he is getting relief from specific treatment. Another case was one in which there was acute amebic infection five years ago and diarrhea lasting since that time in which the organism had never been found.

In that connection I want to mention again the difficulty, but also the tremendous benefit which is obtained from sigmoidoscopic study.

We must think of the possibility of diarrhea representing habit, representing psychic shock, representing unrecognized organic cause.

DR. SARA M. JORDAN (Boston): I would like to ask Dr. Brown in how many cases he found that catharsis and colonic irritations were not only not helpful but might possibly have been part of the cause of the condition, especially in the so-called irritable colon.

I would also like to say in our experience both the barium meal and the barium enema have been of value. The nine-hour picture especially, but sometimes the six-hour picture, shows the rapidity with which the barium passes along. And that seems to me a very important point in the diagnosis. The barium enema is helpful not only in the determination of the amount of material required to fill the colon but the rapidity with which it passes in. It is also of importance to determine the caliber of the colon as it passes over toward the cecum and also the distress which it causes the patient. We found that the normal colons do not react with distress to the reception of the barium, and that the barium passes in a very definite time over to the cecum, usually between two and four minutes. Also that the caliber is of a standard size; whereas in the irritable colon it is either very much diminished or very much too large.

DR. WARREN T. VAUGHAN (Richmond, Va.): Dr. Brown has brought out the observation that the skin tests are often negative, as I attempted to bring out in my paper. I think probably all of you recall Dr. Thomas R. Brown's paper which came out several years ago, on the food factor in migraine. He also observed that one frequently obtains what one might call false negative sensitization reactions.

Of course there are several possible reasons for this: First, our methods of preparation of the extracts are in the last analysis pretty crude. We do not know exactly what we have. I think in Dr. Thomas Brown's paper he mentioned chocolate. I know in my own experience we very infrequently get a positive reaction to chocolate and yet chocolate is a frequent offender.

The other possibility and I think this often happens, is that the reacting tissue is

limited to the intestinal tract and there are no reacting bodies in the skin. It is possible that with better methods of preparation of allergenic test substances we may, as time goes on, get a higher proportion of truly positive skin reactions.

Of course the elimination diet is not new, any more than allergy is new. Hurst, many years ago, in his book on constipation, discussing colitis, especially mucous colitis, brought out the close analogy to asthma with muscle spasm and catarrhal secretion, eosinophiles in this secretion. He remarked on the close similarity to asthma, but did not draw the analogy any further. He described a very simple elimination diet in that all he did was start his patients on milk and as they improved, added one food at a time. And in essence that was a trial diet or elimination diet.

I spoke yesterday of the extremely interesting case of Dr. Alvarez in which cheese was found to be the causative factor, not by keeping a food diary alone, but by keeping a record of the daily events of the patient's experience.

Cheese is quite an interesting factor. There are many kinds of cheese. Of course Roquefort cheese is made from sheep's milk; Giedeost, a Dutch cheese, is made from goat's milk. Most cheeses are made from cow's milk, but they vary because the taste of cheese depends upon the mold growing in it, and each variety of cheese has been ripened with a different type of mold. So really we are dealing with different foods in different types of cheeses.

I would also like to say that Dr. Alvarez, so far as I know, was the first man who started the more modern work on the elimination diet.

DR. PHILIP W. BROWN (*Closing*): I left out a paragraph containing a point which was emphasized very nicely by Dr. Brown and Dr. Alvarez. All of these patients without exception, irrespective of stool examination, were given a therapeutic trial of emetine and treparsol and those cases that responded to the use of emetine and treparsol we have dropped out of this group because we do not consider them indeterminate diarrheas.



THE DIAGNOSIS OF JAUNDICE

VALUE OF CLINICAL AND LABORATORY DATA*

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WHEN a patient with jaundice presents himself, certain questions arise: What has happened to turn the bile into his blood? Is there an obstruction and can it be relieved? Will the trouble clear up spontaneously or will a surgical procedure be necessary? If an operation is performed, what is likely to be found and what can be done? What are the dangers of this operation and can anything be done to obviate them? What does the future hold for the patient?

There are three principal ways in which jaundice develops: (1) from production of more bilirubin than the liver can excrete; (2) from obstructive lesions occurring in the biliary tract, or (3) from some functional derangement of the polygonal hepatic cell, interfering with excretion of bilirubin. On this basis, McNee has classified jaundice as of hemolytic, obstructive, or toxic and infectious (hepatic) origin. At the clinic, we have found this a satisfactory working classification. Each of these groups of cases presents a different therapeutic problem and hence a quick classification of any case of jaundice into one of these types is desirable. This is especially true when it is recalled that obstructive lesions are those most frequently encountered, and that if unrelieved they lead to much injury to the biliary passages and hepatic parenchyma.

LABORATORY DATA

Although the differentiation of jaundice is and should continue to be based largely on clinical criteria, laboratory procedures are useful, and McVicar and Fitts have suggested the following as a working procedure: (1) determination of whether

the reaction of jaundiced serum to the van den Bergh reagent is direct or indirect; (2) determination of the height and behavior of the curve of serum pigment as plotted from results of the van den Bergh test or from the icterus index; (3) determination of the quantity of bile reaching the intestine, as recovered by siphonage of the duodenal content, and (4) determination of the presence or absence of pain and of its character when present. With these data at hand, a working diagnosis can usually be reached. If an anatomic diagnosis cannot be made positively, the case usually can be classified as surgical or nonsurgical.

There is evidence in the literature of considerable difference of opinion in regard to some of the functional tests of the liver. The liver has multiple functions, a large reserve capacity, and an ability to regenerate rapidly after severe injury. From a practical standpoint, in jaundiced patients, the clinician will employ any one or more of the proposed tests if he finds that they will supply him with useful data in regard to the following: (1) to aid in determining whether the jaundice is hemolytic, obstructive, or hepatic or in determining if there is more than one type of jaundice present; (2) to give some idea of whether the reserve capacity of the liver is sufficient to enable the patient to stand surgical procedures when indicated and to recover, especially when obstruction is present; (3) to give some idea as to the prognosis in hepatic jaundice, and (4) to determine the most favorable time for operation, or indication for any particular type of treatment. I do not propose even to list the various tests of hepatic function,

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but I wish to present the results of observations of certain tests.

Van den Bergh Tests. In the experience of our section the qualitative and quantitative van den Bergh tests have given more definite and useful data than any of the others. The determination of the character and amount of bilirubin in the serum gives a much more accurate idea of the type of the icterus, its severity, and its fluctuations than does examination of the urine and feces or study of the color of the skin. By means of the van den Bergh reaction, hemolytic jaundice, in which an indirect reaction is usually obtained, can be distinguished from obstructive or hepatic jaundice. An occasional case of hemolytic

more than 8 or 10 mg. in each 100 c.c. of serum. In the hepatic group the value for retention of pigment may be extremely high and seems to be proportionate to the severity of the disease. Table 1 gives the values for serum bilirubin in a group of 224 cases of obstructive jaundice and in 100 cases of hepatic jaundice. More than 70 per cent of the cases in which the disturbance is due to stone or stricture of the common bile duct have a value for serum bilirubin of less than 10 mg. in each 100 c.c., the highest readings for bilirubin occur in cases of malignant obstruction and hepatic icterus, and a value for serum bilirubin of more than 30 mg. in each 100 c.c. is presumptive

TABLE 1
SERUM BILIRUBIN IN VARIOUS TYPES OF OBSTRUCTIVE JAUNDICE

Serum Bilirubin, Mg. in Each 100 C.c.	Stone in Common Bile Duct (102 Cases)		Stricture of the Common Bile Duct (46 Cases)		Carcinoma of Pancreas (36 Cases)		Carcinoma of Gall Bladder and Ducts (16 Cases)		Cholecystitis with Stones (24 Cases)		Intrahepatic Jaundice (100 Cases)	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
1 to 5	42	41	20	43.5	4	11	1	6	8	33.0	18	18
6 to 10	30	29	14	30.5	5	14	3	19	6	25.0	27	27
11 to 15	21	21	7	15.0	8	22	4	25	5	21.0	18	18
16 to 20	8	8	3	7.0	12	33	8	50	2	8.5	11	11
21 to 25	1	1	1	2.0	5	14	..	..	2	8.5	9	9
26 to 30	..	..	1	2.0	1	3	..	..	1	4.0	4	4
31 to 35	..	..	..	..	..	..	..	..	..	..	4	4
36 to 40	..	..	..	..	1	3	..	..	..	..	4	4
41 to 45	..	..	..	..	..	..	..	..	..	..	3	3
46 to 50	..	..	..	..	..	..	..	..	..	..	2	2

jaundice is seen in which the van den Bergh reaction is delayed direct or indirect, suggesting possibly some disturbance of the parenchymal hepatic cells, but the larger part of the pigment present gives an indirect reaction. The character of the reaction does not aid in distinguishing obstructive from hepatic jaundice, or in determining whether there is an hepatic element present in the case with obstruction. A measure of the retention of bilirubin in the blood serum, however, does give some assistance. In hemolytic jaundice it is extremely rare for the reading to be

evidence of hepatic origin of the jaundice. There is also much evidence to suggest that in benign, incomplete obstruction, persistent elevation of bilirubin of more than 15 mg. is strong evidence of an associated intrahepatic element in the production of the icterus.

Groups of cases of stone in the common bile duct, cicatricial stricture, carcinoma of the pancreas, and carcinoma of the gall bladder or bile ducts, in which there was evidence of complete obstruction, were selected. It was surprising to find that the bilirubinemia averaged practically the same

in the four groups; that is, from 16 to 18 mg. for each 100 c.c. It is difficult to explain the finding of much higher readings

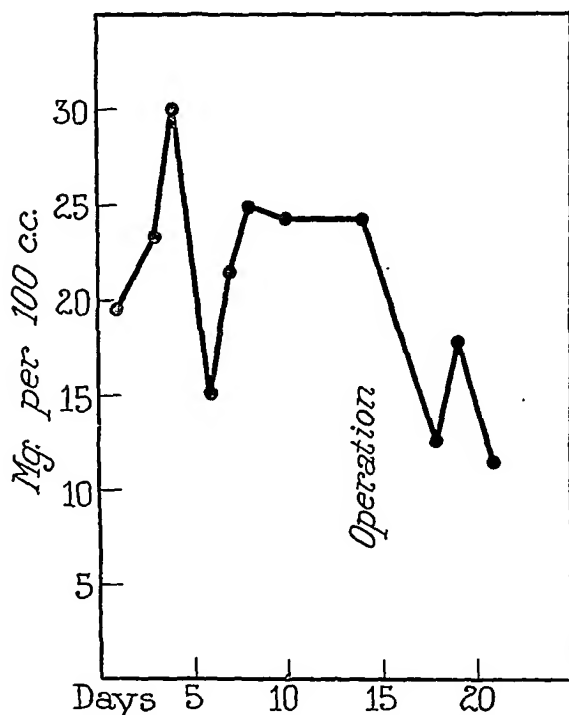


FIG. 1. Concentration of serum bilirubin showing marked fluctuation preoperatively.

than this average in these cases if the icterus is considered to be due solely to obstruction. It is equally as difficult to explain the cases in which the readings are much lower than the average. In some of the latter, associated anemia or long duration of the icterus may be a factor, but in many cases these are insufficient reasons for the low readings.

A single determination of the concentration of bilirubin in the serum is helpful in giving an accurate gauge of the degree of icterus and classifying its type, but more information can be obtained by following the curve from day to day, for significant changes may not be observable clinically, and important hints in regard to the clinical course, diagnosis, therapeutic indications or contraindications, and prognosis, may be obtained. In the obstructive group, declining bilirubinemia indicates a favorable course and greater safety for surgical procedures, whereas a rising curve

argues for delay in surgical intervention. An adjustment of some kind is taking place, and it is much safer to delay operation until equilibrium is established and the curve remains at a definite level.

Sudden fluctuations in the amount of bilirubin in the serum suggest that there is a little less obstruction, and this usually means the presence of a cause of intermittent obstruction, such as calculus. The following case illustrates this point and also the probable hepatic factor associated with an obstructive lesion.

A woman, aged sixty-one years, registered January 27, 1931. In May and in September, 1930, she had had moderately severe attacks of "acute indigestion," requiring opiates for relief. In December a similar attack had occurred, followed by jaundice. This had now been present for a month, and there had been loss of weight of 30 lb. Aside from the icterus which was of a brilliant yellow type, nothing significant was found on general examination. There was considerable anemia. The percentage of hemoglobin was 50 and erythrocytes numbered 3,790,000 in each cubic millimeter of blood. On duodenal drainage evidence of free flow of bile was obtained. The concentration of serum bilirubin was 19.7 mg. in each 100 c.c. on admission, but the rapid fluctuation illustrated in Figure 1 suggested intermittent obstruction. This was confirmed by subsequent occurrence of a Charcot type of fever. The high retention of bilirubin, in spite of the free flow of bile into the duodenum, the anemia, and the brilliant yellow type of icterus suggested an associated hepatic element in the production of the icterus. At operation the gall bladder and cystic duct were full of stones; the common bile duct was much dilated and contained two stones, lying loosely in the ampullar region. The liver, grossly, appeared in fairly good condition. Death due to complicating bronchopneumonia prevented further observation of the degree of hepatic involvement or of its response to relief of the obstruction.

It has already been mentioned that bilirubinemia of 30 mg. or more is presumptive evidence of the hepatic origin of the jaundice. In the presence of bile entering the intestine, and in the absence of pain,

this is especially true, and under these conditions, values for serum bilirubin much lower than 30 mg., even as low as 15 mg., are very suggestive of hepatic jaundice. The intensity of the bilirubinemia is usually suggestive of the severity of the hepatic injury, although it does not necessarily parallel the clinical symptoms. For example, a patient whose serum bilirubin measures 50 mg. in each 100 c.c. may rapidly recover, whereas one with 20 mg. in each 100 c.c. may have a condition which is progressing to yellow atrophy. In Table I it will be noted that 26 per cent of the patients with hepatic jaundice had a value for serum bilirubin of more than 20 mg. and 13 per cent of more than 30 mg. It is difficult to explain the apparent discrepancy between this marked bilirubinemia seen in cases of hepatic jaundice, in which the ducts are patent and that occurring in cases of obstructive jaundice, even when the occlusion is complete.

The behavior of the curve of bilirubin in hepatic jaundice also offers some diagnostic and prognostic assistance. A persisting high value, with little fluctuation, suggests extensive injury to the liver. A rapidly falling curve is usually a good omen whereas a slowly falling curve indicates more serious injury.

Excretion of Dye. The rate of disappearance from the blood of dyes which have a selective property, so that they are excreted through the liver, has attained deserving popularity in recent years. In cases in which patients are not jaundiced, the dye tests give valuable information. This is especially true in the differential diagnosis of ascites, or in determining the efficiency of the liver in such conditions as Banti's disease when splenectomy is being considered. In certain types of hemolytic icterus, some information concerning hepatic function may be gained, and it is also demonstrated that in cases of obstructive and hepatic jaundice, when the icterus has about cleared, there is still evidence of some injury to the parenchymal hepatic cell as demonstrated by these tests.

Generally speaking, however, among jaundiced patients these tests seldom give information that cannot be obtained by simpler methods.

Coagulation Time and Sedimentation Rate of Erythrocytes. The hemorrhagic tendency in jaundice leads to the complication that is chiefly responsible for the surgical risk. In most instances this tendency is detectable by measurement of the coagulation time, and by the presence of purpura or of slow oozing from incised surfaces. Occasionally, in severe cases, there may be spontaneous bleeding from supposedly intact tissues or, rarely, evidence of thrombocytopenia. Snell, Vanzant, and Judd recently summarized knowledge of this hemorrhagic tendency. The sedimentation rate has been shown to be increased in jaundice, but Burke has been unable to demonstrate any relationship of this to the type of jaundice or to any hemorrhagic tendency. It is sufficient to say here that frequent determination of the coagulation time is an important laboratory procedure in cases of jaundice, remembering, however, that the tendency to bleeding may not always be demonstrable by this means, that it may occur in cycles, and that this natural variation should be remembered in selecting the time for necessary surgical intervention and in evaluating the results of treatment.

Urobilin and Urobilinogen. Determination of the concentration of urobilin and urobilinogen in the urine has been advocated as a means of differentiating types of icterus. From a theoretical standpoint, it might appear valuable in determining complete obstruction of the bile ducts, but in the cases in which assistance in differential diagnosis is most needed, that is, in distinguishing between cases of hepatic jaundice and those due to partial obstruction, it can be of little if any, assistance. I have not noted any assistance from demonstration of urobilin or urobilinogen in the urine from either a diagnostic or prognostic standpoint. McVicar

and Fitts summarized their impression of the significance of this test.

Lactic Acid and Sulphates in the Blood. Study of the lactic acid in the blood has also been suggested as a test for hepatic

cases, the results were lower than normal. In others, there was a slight increase, but it was not sufficiently great or frequent to be of diagnostic value. There appeared to be no correlation with the degree of

TABLE II
CHOLESTEROL, CHOLESTEROL ESTER AND LECITHIN IN CASES OF JAUNDICE

Case	Preoperative			Postoperative			Degree of Obstruction	Diagnosis and Comment
	Mg. in Each 100 C.c. Plasma							
	Choles-terol	Choles-terol Ester	Leci-thin	Choles-terol	Choles-terol Ester	Leci-thin		
1	715	379	1041	667	287	1248	Complete	Carcinoma of hepatic ducts; exploration
2	230	94	544	287	137	578	Complete	Obstructive jaundice, probably carcinoma
3	...	..	....	184	151	215	Almost complete	Carcinoma of pancreas; cholecystogastrostomy
4	287	105	568	145	...	378	Almost complete	Carcinoma of pancreas with metastasis to liver; ex- ploration
5	387	216	568	321	170	355	Moderate	Carcinoma of pancreas with metastasis to liver; ex- ploration
6	574	277	1041	188	142	284	Moderate	Carcinoma of right hepatic duct; removal
7	...	...	....	347	185	544	Moderate	Carcinoma of gall bladder; exploration
8	113	49	297	...	...	...	Moderate	Carcinoma of pancreas; cholecystogastrostomy
9	...	...	....	146	75	272	Mild	Carcinoma of pancreas
10	...	...	....	74	37	139	Slight	Carcinoma of pancreas
11	185	89	347	189	152	320	Marked	Cholecystitis with stones; obstruction of common bile duct
12	196	101	380	...	...	...	Moderate	Stone in common bile duct removed
13	297	175	478	...	...	...	Moderate	Stones in gall bladder and obstruction of common bile duct
14	185	150	223	158	104	223	Mild	Stone in common bile duct; T-tube
15	565	277	1156	350	228	473	Complete	Stone in common bile duct removed; T-tube
16	340	282	347	189	167	208	Mild	Stone in common bile duct removed; T-tube
17	62	54	178	85	64	164	Slight	Stone in common bile duct; external biliary fistula
18	208	98	355	260	216	297	Marked	Stricture; excision and reconstruction of common bile duct
19	595	379	1248	245	163	290	Marked	Stricture; hepaticoduodenostomy; pregnancy
20	422	175	568	211	89	312	Complete	Stricture; reconstruction over T-tube
21	..	...	....	383	219	696	Marked	Stricture and biliary cirrhosis postoperatively
22	318	143	478	...	...	...	Marked	Stricture; hepaticoduodenostomy
23	154	79	290	...	...	...	Mild	Stricture; biliary fistula; suppurative hepatitis
24	...	...	....	337	139	595	Moderate	Stricture postoperatively; T-tube
25	206	144	320	155	103	233	Mild	Stricture; external fistula; transplantation
26	238	175	328	...	...	...	Slight	Stricture; duodenal fistula; hepaticoduodenostomy
27	354	204	594	358	173	544	Complete	Obstruction of the common bile duct; pancreatic cyst; jaundice unrelieved
28	241	131	390	...	...	...	Marked	Hepatitis; cleared in three weeks
29	135	56	201	...	...	...	Moderate	Postarsphenamine jaundice
30	137	49	215	..	...	...	None	Acute yellow atrophy from cinchophen
31	238	136	328	..	...	...	Slight	Biliary cirrhosis
32	378	278	520	..	...	...	Mild	Residual hepatitis with jaundice; secondary biliary cirrhosis
33	219	189	338	...	...	...	Slight	Secondary biliary cirrhosis
34	175	143	205	...	..	...	Mild	Atrophic cirrhosis (alcoholic) with ascites
35	105	75	195	...	...	...	None	Cirrhosis with ascites
36	128	84	189	...	...	...	None	Cirrhosis with syphilis

insufficiency. Wakefield and Greene reported their experiences with this test in a series of 20 cases from The Mayo Clinic. Their opinion is that, with the method used, the resting lactic acid content of the blood gave no information. The usual normal values obtained by the method employed ranged between 10 and 15 mg. in each 100 c.c. In several of their

retention of bilirubin. Wakefield and Greene also reported their studies of the sulphate fraction of the blood. They found a reduction in the ethereal or conjugated sulphates in 11 of 26 cases. These 11 patients were seriously ill. More recent work, however, on the method for inorganic and conjugated sulphates, has shown that many normal persons do not

have measurable quantities of conjugated sulphates in the blood, indicating that their absence from the blood does not necessarily mean hepatic injury. It has been found further, that some conjugated sulphates may occur in the urine in the absence of any in the blood, but the amount as compared to the total content of sulphates is lower than the usual 10 per cent. Further work is necessary on the sulphate content of both urine and blood in normal and pathologic states.

was elevated. Among the 9 cases with normal values, there were 6 in which postoperative determinations were made and these were also normal. In these 6 cases there was only slight icterus, except in 1 case in which there was marked hepatitis and a concentration of serum bilirubin of 18.6 mg. Among the 16 cases in which the amount of fat in the blood was elevated preoperatively were 6 in which the values were normal postoperatively, 6 in which there was decided decline, 3 in which there

TABLE III
CHOLESTEROL, LECITHIN, TOTAL FATTY ACIDS AND TOTAL LIPOIDS IN CASES OF JAUNDICE

CHOLESTEROL, LECITHIN, TOTAL FATTY ACIDS, TOTAL LIPIDS												
Case	Serum Bilirubin Mg. in Each 100 C.c.		Preoperative				Postoperative				Degree of Obstruction	Diagnosis and Comment
	Preoperative	Post-operative	Mg. in Each 100 C.c. Plasma									
			Cholesterol	Lecithin	Total Fatty Acids	Total Lipoids	Cholesterol	Lecithin	Total Fatty Acids	Total Lipoids		
37	2.2	1.5	160	300	340	500	142	230	370	512	None	Stone in common bile duct
38	7.1	4.3	294	358	653	947	184	270	373	557	None	Stone in common bile duct
39	7.9	3.1	260	280	519	779	107	195	918	1025	Partial	Stone in common bile duct
40	4.5	1.8	387	644	781	1168	125	250	1036	1061	Partial	Stone in common bile duct
41	21.0	10.0	194	496	880	1074	158	410	774	902	Complete	Cholecystitis with stones; compression of common bile duct
42	18.7	7.9	238	338	647	885	185	356	702	887	Partial	Stone in common bile duct; hepatitis; necropsy
43	23.0	11.5	173	356	813	996	128	338	1862	1990	Partial	Stone in common bile duct; hepatitis; death
44	7.9	3.0	746	1136	1967	2713	151	269	455	606	Complete	Stricture of common bile duct
45	8.8	1.7	450	624	1049	1449	336	328	699	1035	Complete	Stricture of common bile duct
46	5.5	2.0	208	267	387	595	196	285	335	531	Complete	Carcinoma of pancreas; external biliary fistula
47	13.8	2.3	617	832	1589	2207	324	312	509	833	Almost complete	Carcinoma of pancreas
48	20.3	....	340	558	965	1315	....	....	....	....	Complete	Carcinoma of gall bladder; exploration

Blood Fat. Although the liver has much to do with metabolism of fat (Tables II and III), the full details are not yet worked out. We have determined the partition of fat of the blood in 48 cases of jaundice due to a variety of conditions. At first it was thought that marked elevation of the amount of fat in the blood might aid in distinguishing obstructive types of lesions from other types. On further observation, however, this has not been found true. In 25 cases in which operative relief of the obstruction was undertaken, there were 9 in which the amount of fat in the blood before operation was normal, and 16 in which it

was no change, and 1 in which there was further elevation. There were 3 other cases in which determinations were not made preoperatively and in which postoperative values were normal. Among the 3 cases in which there was no change after operation, the jaundice was not relieved in one, the elevation of the blood fats was only slightly more than normal in another, and in the third there was marked hepatitis associated with calculi of the common bile duct, and the icterus did not clear postoperatively. In the case in which the values for blood fat were elevated after relief of the obstruction, there also was extensive hepatitis associated with chole-

docholithiasis. There were 17 other cases in which no operation, or only exploration, was undertaken. In the 8 cases in which there was obstruction, there was elevation of the concentration of blood fats. The values for blood fats were elevated in 4 of the remaining 9 cases of hepatic jaundice. No correlation was demonstrable between the degree of elevation of values for blood fat and the lesion producing the jaundice. In general, in the cases in which there was marked elevation of blood fats there was marked biliary obstruction, but in many cases in which there was marked obstruction, also, there were normal or nearly normal values for blood fats.

Sugar Tolerance Tests. The important relationship of the liver to metabolism of carbohydrate has long been recognized, and evidences of disturbed glycogenic activity have long been sought in hepatic

of tolerance tests must be made with great caution. Greene and his associates have reported their experience in the clinic with the use of the fructose tolerance test in obstructive jaundice in carcinoma of the liver and bile ducts, in certain diseases of the hematopoietic system, and in various types of syphilis of the liver. Although positive tests were obtained, it was with great irregularity. There was the additional difficulty of eliminating associated pancreatic disease and other factors. They questioned the clinical usefulness of the test.

Table iv gives the results of determination of the tolerance to fructose in cases of jaundice of hepatic origin. The criteria of Tallerman were accepted in determining any lowering of tolerance. Cases 49 to 55 were acute, and were of the nature of catarrhal jaundice; Cases 56 and 57 were chronic cases of jaundice of undetermined origin. Two of the patients with the acute

TABLE IV
FRUCTOSE TOLERANCE TEST

Case	Serum Bilirubin, Mg. in Each 100 C.c.	Results in Terms of Glucose, Mg. in Each 100 C.c.				Result of Test†	Comment
		Fasting	After 100 Gm. Fructose				
			1 Hour	2 Hours	Change*		
49	41.2	78	135	107	54	Positive	Jaundice for two weeks
50	24.2	87	294	275	507	Positive	Diabetes
51	2.9	86	107	109	23	Negative	
52	17.3	84	105	84	21	Negative	
53	1.1	90	89	88	1	Negative	Icterus absent
54	1.9	93	114	105	21	Negative	Icterus absent
55	3.6	93	126	85	33	Positive	Pernicious anemia with hepatic icterus
56	20.5	92	121	112	29	Negative	Exploration
57	7.8	93	112	96	19	Negative	Icterus for three and a half years

* Difference between value fasting and highest value after administration of fructose.

† Change of more than 30 or rise above 135 = positive.

disorders. Particular attention has been paid to studies of tolerance to carbohydrate. Glucose, fructose, and galactose have been the main sugars studied. Although the liver is definitely concerned in metabolism of carbohydrate, it must be remembered that many other factors are concerned, and interpretation of results

type of jaundice had lowered tolerance; one of them also has diabetes, and the other had very deep jaundice (serum bilirubin 41.2 mg. in each 100 c.c.) of two weeks' duration. In no instance was the value for fasting blood sugar abnormal. Further work with this test was not carried out because of negative results.

We also have used the galactose tolerance test in jaundice and hepatic conditions, and although definite changes in tolerance occur, we do not feel that the test is sufficiently specific to warrant stating that a case is of obstructive or hepatic jaundice, or that operation is or is not indicated.

Blood Guanidine. Minot and Cutler have found that guanidine is retained in the blood of dogs that are poisoned with carbon tetrachloride. High intake of carbohydrate and calcium produced marked increase in tolerance to the drug, and relief from symptoms of intoxication. The inference is that possibly in cases of hepatic disease there might be retention of guanidine. We have determined by Pfiffner and Meyer's method the guanidine content of the blood in a small series of cases of hepatic disease, but to date have obtained only normal results. Possibly in cases of more acute intoxication or degeneration there may be some increase in guanidine. However, in such cases it is necessary to exclude any associated renal involvement.

Patency of Bile Ducts. Duodenal intubation is used more than formerly because it gives more definite information concerning the amount of bile entering the intestine than does examination of the feces. Patency of the ducts seldom enters into the question of diagnosis if jaundice is of the hemolytic type. If jaundice is of purely hepatic origin, bile always can be demonstrated to have entered the intestine, although in certain stages of acute, severe types of hepatic jaundice there may be temporary suppression of excretion of bile. Pathologically in cases of hemolytic and hepatic jaundice, there is no question of obstruction of the larger ducts. In cases of obstructive jaundice, determination of the patency of the biliary tract is an important aid in diagnosis. Table v gives an analysis of a group of cases in this respect. Although other groups of cases may give percentages which vary somewhat from these, it is felt that these represent approximations

which are satisfactory in general. It will be noted that there is evidence of patency of bile ducts in a high proportion of the cases of stone and the reverse in the cases of malignancy. Cicatricial stricture occupies an intermediate position. Although it cannot be claimed that patency or complete occlusion is in itself diagnostic, yet the degree of patency, taken in consideration with other facts, aids materially in arriving at a diagnosis, and is of value in indicating therapeutic procedure.

TABLE V
PATENCY OF BILIARY PASSAGES

	Partially Patent		Not Patent	
	Cases	Per Cent	Cases	Per Cent
55 cases of stone in common bile duct.....	50	91	5	9
31 cases of stricture of common bile duct....	25	80	6	20
26 cases of carcinoma of pancreas.....	8	31	18	69
13 cases of carcinoma of gall bladder and ducts.	3	23	10	77

CLINICAL DATA

Pain is seen chiefly in obstructive jaundice. It is extremely rare in hemolytic or hepatic jaundice, although occasionally it occurs and may be due to complications. I reviewed recently 275 cases of jaundice, in which operation or necropsy was performed, with regard to the incidence and character of pain. Among 104 cases of stone in the common bile duct, there was colic associated with the onset of icterus in 80; in 19 the onset was painless. Among 49 cases of benign stricture, colic occurred in 22. In 38 cases of pancreatic neoplasm, colic occurred in 5, and icterus had its onset painlessly in 19. In 38 miscellaneous cases of cholangitis, hepatitis, cirrhosis, and so forth, colic was present in 12, and there was a painless onset in 21. Atypical pain of various types occurred in all groups. Colic is the most typical pain in disease of the biliary tract, and when associated

with jaundice strongly suggests stone in the common bile duct. However, in the presence of stone pain may be absent, or it may be replaced by milder equivalents. Pain may occur in other conditions, such as cholecystitis with or without stones, stricture of the common bile duct, cholangitis, malignancy of the pancreas or the biliary tract, or in some cases of primary hepatic disease.

In distinguishing cases due to stricture from cases due to stone in the common bile duct, when operation has been performed previously, difficulty is also encountered. The patient with stone is usually free from symptoms after operation much longer than the patient with stricture. Among the cases due to stone, the average interval, in the cases reviewed, was three years and eight months. Jaundice occurs at a longer interval after operation in cases of stone than in cases of stricture unless there is persisting jaundice or biliary fistula. Immediate jaundice or persisting fistula suggests stricture. Strictures are accompanied by colicky pain much less frequently than stones. Stricture occurs as a rule only after cholecystectomy.

Cases in which pain is absent offer greatest difficulty in differential diagnosis, but if the history, results of general examination, and laboratory data are taken into consideration, a satisfactory conclusion usually can be reached. If patients are young, painless icterus is usually hepatic in origin, especially if there is evidence of an epidemic. In later years, painless icterus may be associated with palpable gall bladder, enlarged nodular liver, or other evidences of malignancy which aid in diagnosis. Painless jaundice coming on shortly after cholecystectomy suggests stricture. In some cases a definite diagnosis cannot be made, and if the patient is in good general condition and the icterus shows no signs of clearing in a reasonable time, exploration must be considered. In the group of 275 cases studied there were 107 cases in which onset of icterus was painless. These cases

were due to benign stricture, pancreatic enlargement that was malignant in most cases, carcinoma of the bile passages, hepatic disease, or stone of the common bile duct.

Other signs and symptoms are frequently mentioned in differential diagnosis, especially the presence of pruritus, whether or not the gall bladder is palpable, the size and consistence of the liver, the presence of diarrhea, and loss of weight. The cause of pruritus in jaundice is unknown. It is likely to be present as often in benign as in malignant disease, and as often in hepatic jaundice as in obstructive jaundice. In 71 cases of stone in the common bile duct pruritus was present in 60 per cent, in 20 cases of stricture of the common bile duct it was present in 95 per cent, and in 26 cases of carcinoma of the pancreas it was present in 75 per cent. In one group of cases of hepatic jaundice that was studied, pruritus was present in more than 90 per cent of the cases. In the individual case it is thus evident that the presence or absence of pruritus does not assist in differential diagnosis. A palpably distended gall bladder may be present in a variety of conditions, such as carcinoma of the pancreas, carcinoma of the gall bladder or ducts, or benign obstruction of the cystic duct. It is most frequently encountered in carcinoma of the pancreas. However, in our experience the frequency with which it can be palpated is much lower than one would expect from figures obtained from textbooks or postmortem reports. In a series of cases of carcinoma of the pancreas that was studied, the gall bladder was palpably distended in approximately 60 per cent of the cases.

The size and consistence of the liver are even more variable from the standpoint of diagnostic value. The presence of a liver of normal size does not exclude a cirrhotic or metastatic process.

SUMMARY

Although much study from a clinical and laboratory standpoint has been de-

voted recently to jaundice and hepatic diseases, the differential diagnosis is and should continue to be based essentially on clinical data. The presence or absence of pain and its character when present is the most important single fact in such differentiation. Laboratory procedures have given new impetus to study of these cases, have changed methods of practice to some extent, and have introduced new conceptions of the mechanism of jaundice. Thus, duodenal drainage to determine the amount of bile entering the intestine is used more frequently because they give more definite information than examination of the feces and urine. The reaction of the serum to the van den Bergh test, and the height and contour of the curve of bilirubin give a much more accurate idea of the type of the icterus, its severity, and its fluctuations than does observation of the color of the skin or examination of the urine and feces. We feel that the van den Bergh test is one of the most useful of the various tests that have been advocated in the study of jaundice. The coagulation time of the blood is also a valuable procedure, but must also be coupled with clinical observation of the patient.

The conception has developed that all jaundice is not obstructive in cause, but that jaundice may also be of hepatic or hemolytic origin. Although the majority of cases are probably distinctly of one type, yet in practice cases are seen in which the icterus originates in more than one way. Thus, the cases of hemolytic jaundice may have an associated hepatic or obstructive element or the cases of obstructive jaundice may have an associated hepatic element. At present there is not any specific test for distinguishing between hepatic jaundice and obstructive jaundice if the obstruction is partial. The need for such a test is especially great when obstruction has developed without the accompaniment of pain.

The mechanism of the icterus in hepatic jaundice is not understood. The classification of the group is unsatisfactory. Although some forms of jaundice, such as that due to chloroform, have largely disappeared, other forms have appeared since the introduction of the arsphenamine and cinchophen drugs. Precautions in the use of these drugs are constantly necessary.

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THE PSYCHIATRIC ASPECTS OF GASTROENTEROLOGY*

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BALTIMORE

I HAVE prepared a paper in which I aimed to lead the physician who is almost exclusively taught to study parts of the organism and their functions to take an interest also in the total-function of the person.

After the papers on various widely disparate facts, nerves, allergy and the constitution, I thought I would rather try to formulate in as objective a way as I can what would be helpful for the physician in dealing with the personality functions or "mental factors" and the consideration of the relation between part-function and total-function of the patient.

I must confess that the discussion has gone into divergent detail in some respects far beyond what I planned to say on the principles of dependable correlations. We have been confronted largely with constitutional differences.

The main interest that activates me in the discussion of gastro-enterological patients is probably somewhat biased. I am not particularly interested in data concerning which I have to accept the fact that the dice have already been cast and that the life is practically nothing but the dance of factors largely settled by heredity and constitution that cannot be affected without highly specialized efforts. The principal interest that I have in a discussion with practitioners with regard to personality study and the relation between personality reaction and part-reaction is, as I feel after hearing these discussions, very definitely in the direction of more obviously accessible and simpler problems.

I have a feeling that we cannot discuss as profitably the constitutional make-ups of unusually involved and fate-determined nature as we might discuss the question of

the rôle of the so-called mental factor in the simpler, more easily manageable conditions. Nevertheless I must say that I am keenly interested in and stimulated by the discussions that have preceded. I do, however, feel that it might be wise to keep rather closely to what is within the reach of every physician, although it naturally is also important to know what is possible to attain in the more difficult problems of modification of behavior patterns.

Allow me, then, to present, instead of a formal paper, some *ex tempore* remarks directly suggested by the present discussion but supplementing it as indicated. I should like to explain why and how I should like to urge the physician to think and work with frank attention to the personality functions, and particularly those which are pliable and within the reach of the practitioner. Instead of speaking of a psychiatric aspect I should rather speak of the personality-reactions to be considered in addition to the local or part-reactions.

It is somewhat unfortunate that we are perhaps very strongly led to carry off from the modern discussion of the personality-reactions the anecdotal and more or less startling facts that one gets out of the very detailed study of the cases in the literature. One is apt to think in terms of topics of life that can be discussed in their proper setting but that cannot always be made the issue of direct questions to the advantage of either patient or physician. The consequence is that a good many patients, who after all have to be treated as plain human beings, as possibly sensitive personalities, become very definitely startled, if not offended, by the questioning by the practitioner who thinks too hastily of what may be the upshot of long and careful studies of the sex con-

* Read before the American Gastro-Enterological Association, Atlantic City, N. J., May 4 and 5, 1931.

stitution and the sex functions and a good many of those things that the individual cannot readily change, but that cannot profitably be probed into in a hurry, as little as it is advisable to poke hastily into wounds with a probe.

For the physician it is of tremendous importance to realize that if he wants to get at facts, he has to give the patient an opportunity to speak without too much of a tendency to shock by searching for finished pictures derived from highly specialized systems such as those of psychoanalysis.

I have no antagonism to the following up of such correlations as the ones that Dr. Draper has particularly emphasized. I think they are of considerable plausibility and they are fundamentally quite interesting and they will be infinitely more interesting to me when I shall be able to derive certain principles by which to help the average individual to make more adequate adjustments.

Instead of leaving the impression that in most cases we have to probe at once into the sex life when we suspect "mental factors" to be playing a rôle, I should emphasize the fact that after all practically every fundamental function can take a lead in the personality constitution, in this sense, that, for instance, the gastrointestinal function may have just as much of a tendency to express the personality and *to be* the personality as the sex function can in its way be the main representative of "the personality" in certain situations and in certain periods of life. I should say that the gastrointestinal receptive, digestive and eliminative functions can become that which expresses, and leads the government of, the person for certain periods of the day or throughout life as a dominant and leading concern. It is in our present cultural situation not so prominent. At the same time I think it worth while to recognize that so much of our actual existence is given over to the intake of food, digestion, and reaction thereto and to the elimination, especially in certain indi-

viduals, that it will form a matter of concern, a matter that offers possibilities of becoming dominant and of playing a very definite rôle when anything goes wrong.

It is quite interesting that from the psychoanalytical side intake and elimination and the reactions thereto have been practically identified with sex preoccupations or associations and undoubtedly there are a good many individuals in whom combinations of that sort are quite prominent. The question then arises: What do we know of gastrointestinal functions assuming the rôle of personality-reactions at the expense of both the structure and the function of the parts under a leading preoccupation?

I like to present the facts as zones or spheres and types of implication which have to be understood as mutual concerns and neither by argument nor by exhortation. The gastro-enterologist finds that a patient comes to him with certain functional and even structural disturbances, and he is confronted with the question: Is the malfunction of the stomach or colon structural-functional, due to some local disorder, or is it essentially derangement due to collisions with other particular components either of the gastrointestinal structure and functions or some other organ complexes or of the personality functions? We get local disturbances which depend upon structure, for instance, in the presence of any irritating content of the stomach and the reaction of the mucous membrane thereto. We may then get a spreading of the reaction of the stomach upon the bowel activity, as an extension of the situation. Similarly the stomach may be upset incidentally to what is a disturbance elsewhere in the intestinal tract. Or an existing enterological disturbance may have to include even more to be intelligible. We may deal with an involvement of the thyroid functions, or a disorder of the adrenals, vitamins or metabolism deficits and things like that. We may find, in a more or less autonomous

form, a neurological involvement of the vagosympathetic balance. Then we may pass to questions of the taste of food, i.e., actually into the field where more or less conscious processes become participants, until we get into those functions where the same activity, also seen autonomously or reflexly as activity of special parts, becomes quite definitely part of the *personality reaction*, i.e., consciously emotional, or actually more or less voluntary functioning. And as soon as we get into that field we have to take into consideration that we are dealing with factors in which we may have to deal with a need of a personality-history with possibly a long and special accumulation of life experiences and reactions.

We may deal with a very direct structural or local irritation in vomiting, or with vomiting that comes from neural reflexes as in seasickness, through an overflow of labyrinthine activity; we might next add the vomiting phases belonging to an even larger circle of facts, namely, the pregnancy vomiting. In still another case we have to confront ourselves with the facts of vomiting from a possibly *fancied* pregnancy, i.e., a personality situation to be understood and digested without ridicule, offense or exhortation. In other words, we get the same type of reaction, i.e., the vomiting, in a number of combinations in which we come to the question whether we are dealing with a non-mental integration or whether we are working with a mentally integrated activity. The conscious or more or less conscious processes are in their way just as real and objective facts and processes to the individual as any other, and indeed facts and situations concerning which the student and physician should acquire as adequate training as about infections, poisons, and functional clashings or inhibitions. Hence the traditional prejudice that the "mental facts" might belong to an unreal world obnoxious to the physician might well be transformed into a realization that they form a simple and direct continuity with the "non-mental" facts.

There then presents itself the question of a practical understanding of what disturbances of the gastrointestinal tract can be part of emotional states, of complex emotional and topical experiences, auto-suggestion and things of that sort, which are mentally integrated processes in contrast to merely physiologically conceived processes, calling for a knowledge of personality functions and personality implications.

What is possible in these directions is a matter of experience and the best opportunity we have of determining this experimentally probably is with hypnosis, because there we have in our possession a method of inducing also less conscious experiences practically dissociated from the general trend, but as clearly active or potent as definitely conscious ones. It should no longer appear strange that with self-suggestion or suggestion by others it is possible to produce structural alterations, since, in the end, all function must be function of structure, as was shown long before Pavlov. It is worth remembering that under suggestion it is possible to bring about such a fundamentally physiological and "physical" process as menstruation obtainable on suggestion on a definitely given hour. The same will hold for the motility and tonus and secretion and circulation of other viscera.

Now if in the light of that sort of condition we size up the susceptibilities of organs in a number of directions or settings, we get in a position where we can make comparison between what occurs in the disturbances that are likely to be attributable to specific non-mental conditions and factors in the organs and those in which we have suspicions that we are dealing with so-called "nervous" affection and personality implications. Evidently the fact that the "nervous" disorder is carried on by neural processes does not make it "non-mental." The question is whether associative links and especially specific emotionally active situations can be demonstrated, and whether they influence

the occurrence or can make the occurrence disappear. The mentally integrated functions are also "physical," but we find them to be part of experiences best studied for what they are and mean to the patient and for ways that bring out mutually intelligible situations.

If a physician attempts to get at facts of this type, he is apt to ask too hastily about things which the patient either guards very carefully and is sensitive about or might not know about, i.e., would have in a form which does not rise in response to a blunt question. If I ask you, "What emotional tendencies are you subject to?" I think most of you would probably for a moment feel blank; you would probably be reminded more readily of emotional things if asked what things are apt to get a rise out of you, and then there gradually would be a looming-up of emotional situations that might be telling also in actual complaints.

So in the study of our patients it is tremendously important to be sensitized to the *facts* and to give opportunities to speak, but without precipitating antagonism by such questions as: Have you or any of your people had hysteria? Or nervousness? That might at once appear as an objectionable charge. One has got to prepare the ground on which the individual can really find an incentive to seek aid instead of blocking the way for further discussion. If a physician bluntly asks questions about certain things which the patient has to deny to save his or her face, something arises which may militate absolutely against the formation of a mutual understanding and may bring about a multiplication rather than a reduction of things that are disturbing.

What I have illustrated as the types of settings and situations to be thought of in vomiting holds also for diarrhea, constipation, the fluctuations of appetite. We only have to think of the biological susceptibility of an animal that is taken from the free life into captivity and a process of domestication where in one way or another

the animal reacts with a loss of interest in food and that at times to the point of starvation. We get equivalents of that sort of thing in depressions in the human being. Nostalgia used to produce very serious pictures in recruits in the armies where now we get the scare-reactions of "shell shock." Today with the ease of changes and the consequent habituation those same tendencies, where they still exist, are very easily smoothed over so that it is rather difficult to get at any very telling and conscious admissions of such emotional factors. But we have to learn to sensitize ourselves to situations that call out the equivalent of those emotional effects which entail the disruption of the gastric and intestinal functions. That in depressions constipation plays a very important rôle, we all realize. Whether we shall succeed in explaining that either neurologically or in any very satisfying way from a general biological point of view is perhaps very remote. It still will be part of depression. What we do want to know is the lines along which we can see variations, fluctuations, and then possibilities of inducing the variations to occur at our will and to the advantage of the patient. Sometimes a part-adjustment will help; but if the disorder is essentially psychobiological, i.e., an implication of the person, it may have to be met on that ground.

Very often colitis has factors of a definite emotional character; and there we are apt to deal with individuals that do give us the picture of a great deal of self-concern and self-analysis, something to be taken into account. It is our task then to reconstruct the real situation in a way intelligible and acceptable to the patient and inviting a desire to correct the combinations and not only the local reaction.

There has been a great deal of controversy about the importance of gastrointestinal disturbances in the production of mental disorders. I suppose it is wisest to weigh carefully how much is part-disturbance and how much is general disturbance. I have not been able to make up my mind

to look upon those things in a categorical way in terms of the "either—or"; it is always wisest to pay attention to the whole range of factors that may be found playing a rôle and that can be reached.

The great difficulty at the present time lies in the fact that the whole of medical education still tends to throw the weight on the things that we know relatively little about before we enter the medical school. And under that influence there is perhaps a cloud formed over the things which we all are supposed to have lived with and to know. And it is for that reason that it is rather difficult for the medical student either to keep, or to resuscitate, the interest in the problems of emotional life and the conflicts that are apt to occur and the relations, let us say, to the cardiac functions or the gastrointestinal functions and so on. The student is apt to be put under obligation to think and speak of "nerves" and not of the obvious or at any rate important facts as found and as known as calling for adjustment. I do, however, hope that it will be possible to get very much more of a practical training along these lines, particularly if a practice can be established of having somebody who is primarily interested in the personality-reactions become a liaison officer in the correlation of the gastrointestinal clinic and the psychiatric clinic. George Stevenson has made an attempt in that direction at the Cornell Clinic. I cannot help but feel that a great deal can be done to get the student into the habit of at any rate familiarizing himself with the socializable disturbances or irregularities that can be reached by a regulation of life. That a good many of us prefer occupation treatment to mere talking is due to the fact that after all we have not yet as excellent control over the things that form the fancy and the thought life of the individual; whereas we look upon performance and activity as the actual functioning and the test of the working of the individual's drives and life. There, in connection with activities, in connection with the behavior outside and

within, and with the planning of constructive behavior, we are doing something that creates at least an opening which is very much to be desired, particularly where one does not have at one's disposal that unlimited time which is required when you tap those parts of the individual's life that are more or less unstable in practically all of us.

I do think that the intimate understanding of the more superficial disturbances of equanimity and of conduct ought to be put as emphatically before the medical student as the more specialistic formulations, which after all ought not to be used as a ready-made code in terms of complexes and mechanisms but which ought to be accepted only where careful study and actual demonstration, and not suggestion by examination, are sure to be had.

I repeat that there are two ways before the psychopathologist. The one way may be taken where he has unlimited time for investigation and where he can allow himself to go into all the features, tap all the points that may or may not ultimately be the true picture of the person's maladjustments and difficulties and opportunities for mending. But the other is that of training one's self to evaluate the assets and opportunities as well as the handicaps and complaints and not to do harm by abrupt and blocking questions. That the questions of plan of treatment ought to be taken up with due consideration of the emotional factors is perfectly obvious, but obvious as it is, it is very little heeded. Sometimes one faces the interesting question whether the desire for operation and the subsequent pleasure of talking of one's operation is not as good a placebo as some other placebos that the practitioner is likely to use. And one has to recognize that one should not necessarily kick at the physician who is using one or another guess in the direction of operative interference and things like that. Nevertheless, I think it is sad that we still do get patients who arrive practically eviscerated, for a

last trial, which very often ought to have been the first—namely, that of getting the life adjustment within the range of socialized health offered while it can be fully used.

That we have a great problem in the patients who become chronic, who apparently do not want to get well, is another issue, viz., the question of invalidism. And there I must say I have seen a variety of procedures, not by any means always the adjustments by so-called deep psychology, but the organization of life with the help of the imagination of a physician where the imagination of the patient may be lacking. After all, we have plenty of experience that this works, and it certainly does work very much more extensively than is the case in the average treatment without training, and seems to figure in the minds of those who are too (I do not want to say physically-minded, because according to my conception all human functioning is also physical functioning) exclusively part-minded, with attention only on a narrow focus.

Where one does find personality conditions, one naturally also runs up against family problems, and the unwillingness of the public to allow us to take a patient under treatment against his or her will and

things of that sort. It is certainly an important thing to carry to the student the idea that, with the raising of the bed "against enteroptosis" and that sort of thing, one may be helping largely by suggestion of considerable benefit with some individuals; but, after all, the organization of the average life is apt to be of a great deal of value and importance as well.

The reason why I have not gone more into the specialized issues, the issues of so-called psychoanalysis and particularly the special types of reduction to one or another system is this: in the first place, after all, there are far more disturbances of the gastrointestinal tract that are personality-functions and personality-determined, than it would be possible to treat with more problematic and protracted types of intensive psychotherapeutic treatment. And I do think that from the point of view of public pathology, the pathology (i. e., the ideas about disease) of the average American individual, it will be something of a relief and something of a help if those things which can be handled with the simple socialized types of regulation and personality adjustment are treated with the simplest methods.



ACUTE PANCREATITIS

ACUTE HEMORRHAGIC PANCREATIC NECROSIS*

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SINCE the first publication on this subject in 1889 by Fitz who made a most complete study of all available cases which at that time could be recognized as coming under this heading, many cases have been reported, but not enough to make the condition a common one. Then came the publication of the general and minute pathology by A. S. Warthin in 1898 in which he reports a careful study of changes in the viscera. The pancreas in his case was much enlarged, weighing 320 gm. It was about three times the normal size, abundantly infiltrated with fat, showing the same necrosis as the omentum and mesentery. The organ was hemorrhagic throughout, the blood from a large hemorrhage having formed a clotted mass to the left of the head of the pancreas.

Klebs in 1870 was first to associate hemorrhage of the pancreas with the severe symptoms which we now recognize as the syndrome of hemorrhage into and necrosis of the pancreas.

The papers of Fitz, Warthin, Klebs and Friedreich give us a fine working knowledge of the disease. There have been many suggestions as to the causes leading up to the sudden onset of symptoms and there is yet much room for additional work in both predisposing and exciting etiology. There has been some considerable discussion which suggests that under this heading of acute pancreatitis we are dealing with two different conditions both clinically and etiologically. One has been called acute hemorrhagic pancreatic necrosis (Opie), and the other acute suppurative pancreatitis. Under the former would come the traumatic variety, both external

and internal trauma, those cases due to the blocking of the duct by stone in the ampulla of Vater or other causes of a backward flow of bile and distention of the gland under pressure, also apoplexy of the organ (Opie) due to a break in a pancreatic vessel.

Friedreich in 1875 presented a more or less complete picture of acute pancreatitis suggesting two varieties: the hemorrhagic, which may result in gangrene, and the suppurative type which was found in the infectious diseases in which abscesses were located in and about the pancreas. There are also, no doubt, many cases of bacterial invasion of the pancreas in mild form which give rise to abdominal symptoms of digestive disturbance, the source of which is unrecognized.

As to the gangrenous type of the disease: There seems to be no doubt that back flow of bile into the duct of Wirsung, whether contaminated by pathogenic organisms or not, will under pressure up to and above 1000 mm.¹ produce acute hemorrhagic pancreatitis or necrosis and gangrene of the gland. It has also been shown that tauricolate of soda of the strength found in the natural bile will when introduced into the duct under pressure bring about the same condition. Injection of artificial gastric juice into the pancreatic duct of animals and the use of other irritating chemicals in the same way caused hemorrhage into the pancreas and death in a few days. The omentum and mesentery showed fat necrosis, so that it appears to require not an infective agent or a susceptible host but

¹Mann, F. C., and Giordano, A. S. *Arch. Surg.*, 6: 1-30, 1923.

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merely overdilatation under pressure by bile or other fluid, a backward pressure distending the gland so as to bring about some slight solution of continuity in the blood vessels.

Apoplexy of the gland has been observed as the cause in a small percentage of cases studied post mortem.

Trauma as instanced in the injury of the gland by the kick of a horse, the passing over the body of the wheel of a wagon, crushing the pancreas against the vertebra, and gunshot wounds of the glands are recognized causes.

In many instances, disease of the pancreas is secondary to diseases of the biliary tract and acute pancreatitis is not an exception. Through obstruction of the duct of Wirsung by gallstones or other obstruction increasing pressure within the gland, through ascending inflammation, through the extension of adjacent abscesses, through direct extension of inflammation and as a source of hematogenous infection, the biliary tract plays a part in the etiology of acute pancreatitis.

The work of Mark Kaufman¹ seems to successfully refute the opinion of Deaver and others as to the lymphatic theory of pancreatitis, i.e. the extension through the lymphatics of infection from the gall bladder and bile ducts to the pancreas producing acute pancreatitis. He suggests that clinical and anatomical data rather than experimental evidence resulted in the belief that the lymphatic route was a source of pancreatic infection but Kaufman's experimental work leaves no doubt as to the faultiness of the lymphatic theory.

Arnsperger admits his failure to so produce the disease while he believes it is clinically possible.

The pancreatitis of infection will not as a rule show fat necrosis while the necrotic pancreas is accompanied by extensive fat necrosis in omentum, mesentery and other tissues. The association of fat necrosis with acute pancreatitis seems

to be a point in differential diagnosis between hemorrhagic necrosis of the pancreas and acute bacterial inflammation of the pancreas of the suppurative type which is not commonly accompanied by fat necrosis. Where abscess is found with fat necrosis it might lead to the conclusion that the abscess was secondary to hemorrhagic necrosis and not a part of a bacterial suppurative pancreatitis.

Infection of hematogenous origin cannot be dismissed with the same conclusion as that of the lymphatic route. Since we believe that no part of the body is free from exposure to acute inflammation of hematogenous origin this cause must be given careful consideration. It seems, therefore, more likely that one variety of suppurative pancreatitis might be attributed to infection of hematogenous origin. Some of the cases which have a gradual onset, with forerunning symptoms having been observed, followed by increasing pain and suppuration rather than hemorrhage and gangrene, I believe, will be found to be due to infection through the circulation. Consideration of the several possible causes of pancreatic abscess suggests separating these cases of the suppurative type into different groups: first, those caused by extending inflammation; second, those of hematogenous origin; third, those that are a part of an infectious disease. (This gland is subject to inflammation quite similar to parotitis and inflammation of it does occur in mumps, and may be followed by abscess.) Fourth, it may be the result of ascending inflammation; fifth, it may follow hemorrhagic necrosis, the onset being sudden with the intense pain and other characteristic symptoms, but in most cases has its origin in infection without the violent symptoms of the necrotic type of pancreatic disease.

Peripancreatitis may exist as an extension from perigastritis or duodenitis or other adjacent inflammations. This was suggested by Chiari who reported a case of round ulcer of the stomach with extending inflammation to the pancreas with abscess.

¹Kaufman, *M. Surg. Gynec. Obst.*, 44: 15-22, Jan. 1927.

The extension of inflammation by contact or spread directly through the tissues is not to be confused with the suggestion that it may extend through lymphatic channels from the gall bladder to the pancreas.

DIAGNOSIS AND SYMPTOMS

The usual symptoms of the gangrenous type of pancreatitis are: intense pain, vomiting, profuse sweating, at times swelling and tenderness, no increase in temperature (sometimes it is subnormal). The skin is a pale dusky color. Shock, collapse and death usually occur on the second to the fourth day or even within a few hours. At operation or postmortem there is evidence of fat necrosis.

The general appearance is that of great toxemia. Doberauer produced such symptoms by transplanting experimental necrotic pancreases within the peritoneal cavity of normal animals.

The pain may be above or below the umbilicus, usually above. There is usually normal or subnormal temperature. The pulse is as a rule rapid and collapse precedes death which frequently occurs in from two to four days from the onset. Vomiting follows soon after pain begins and may be frequent and persistent.

The recognition of this condition is at all times difficult, and unless we have in mind this infrequent pancreatic tragedy, the usual painful pathological conditions of the upper abdomen are likely to be considered instead of this greater catastrophe. The very severity of the attack with its shock, agonizing pain, profuse sweating and the recognition of the patient's state as one of extreme gravity far beyond the common acute pathological conditions of the pancreatic region are the keys to the diagnosis.

The matter of most importance in diagnosis is not to differentiate before operation but to recognize when an acute surgical abdomen exists and not to delay operation when it is known that a matter of hours may be of such tremendous

importance in saving the life of the patient. It is a fortunate situation when the patient can be seen almost at the onset of the pain. Case 1 here reported was seen within a few minutes of the onset and was given a half grain of morphine sulphate and sent at once to the hospital where the abdomen was opened without any unnecessary delay.

There is a group of cases of the necrotic type which gives the following general history: A man in robust health in middle life inclined to over nourishment, carrying a little more than the normal amount of fat, having had no previous symptoms, after a full meal is suddenly the victim of a severe and agonizing pain in the upper abdomen. The prostration, shock and general severity of the attack should lead to at least a tentative diagnosis of acute pancreatitis.

TREATMENT

The treatment of all forms of acute pancreatitis is, I believe, surgical. In the hemorrhagic necrotic type surgical interference should be immediate.

In the case of more gradual onset with inflammation and abscess some delay might not be disastrous but from our somewhat limited experience we believe that the interest of the patient will be best protected by very early operation.

Deaver questions the advisability of operation in some cases of profound shock but in fulminating cases he advises immediate surgical intervention.

CASE HISTORY

H.B. male, aged forty.

Chief Complaint: Severe pain in the upper abdomen.

Analysis: For the past two years the patient has had indefinite pains in the abdomen from time to time. His friends state that during this time he has had occasional attacks of abdominal pain after meals. He claims only belching and fullness after meals but says he is a heavy eater. About a month ago the patient had a somewhat more severe attack of pain but it cleared up after the vomiting of food.

The present condition started suddenly at about 3 P.M. on May 20, 1930 while the patient was at work at his desk. He was attacked by a severe abdominal pain and went at once to a drug store for medication but the condition only became worse. Gastric lavage and vomiting did not relieve the pain which was still growing worse. The patient was becoming weak and was sweating profusely. He was given a half grain of morphine and sent at once to the hospital for operation.

Past Medical History: There had been vague abdominal pains occasionally for one and one-half years which cleared up after medication. No serious illnesses.

Past Surgical History: No major operations.

Family History: Wife is living. Father and mother are both dead, the former of glaucoma and the latter of a streptococcic sore throat. No acid fast or malignant history.

Social History: The patient works as an accountant. He sleeps eight to nine hours daily. He drinks coffee, liquor and smokes very little.

Physical Examination: The patient is a well-developed, well-nourished white adult male lying in bed apparently suffering from acute, very severe, surgical abdomen. Head and Neck. The head is well shaped. Eyes react to light and distance, movement of eyes is normal. Nose and ears are normal. Teeth are in fair condition. Tonsils are in good condition. Thyroid is small.

Chest: The chest is moving but little and there is present the grunting type of respiration, characteristic of an abdominal catastrophe.

Cardiovascular: The heart rate and rhythm are slow and regular. Pulse shows no irregularities. Heart is within normal limits.

Abdomen is boardlike in rigidity. Peristalsis is present but slightly. Nothing can be felt. The patient is writhing and groaning with intense abdominal distress.

Reflexes: Hypo-active.

Adenopathy: Negative.

Blood sugar 140.

Impression: Acute pancreatitis.

Final Diagnosis: Acute hemorrhagic pancreatic necrosis.

Surgeon's Report: Aged forty, admitted May 20, 1930. The patient has always been a big eater. He is exceptionally well nourished. He has had indefinite pain in his epigastrium at times for two years. Has had much fullness and

belching after foods at times. One hour before admission the patient was suddenly seized with acute severe pain in his epigastrium. He was nauseated and his pain was not relieved by a fourth of a grain of morphine. He consulted Dr. Jones and was brought to the hospital immediately. On admission his symptoms were those of acute pancreatitis or perforated duodenal ulcer. His pain was agonizing. His abdomen was tense and distended. Peristalsis was slow. Temperature 96°F., pulse 90, respiration 24. Laparotomy was performed on admission. Gas anesthesia was used. On opening the peritoneum, I found blood-stained serum under the liver around the gall bladder and duodenum. The stomach, duodenum and gall bladder showed no evidence of disease. The head of the pancreas was hemorrhagic and edematous. The body of the pancreas was firm and lobulated. I did not search the lower half of the abdomen. I opened the peritoneum over the head and right half of the pancreas and drained with two large cigarette drains and a rubber tube. The spots of fat necrosis, so commonly seen in acute pancreatitis, were not in evidence, perhaps because of the earliness with which this patient came to operation. After operation pancreatic fluid drained and there was quite a little sloughing of the tissues around the drains (due to action of the pancreatic fluid). After the drains were removed his incision closed promptly. I saw the patient about two weeks ago and he claims excellent health.

The point that I would make with reference to this acute hemorrhagic pancreatic necrosis is to urge operation as early as possible. I believe this patient's life was saved because I saw him within twenty minutes from the time the pain began.

DISCUSSION

DR. JULIUS FRIEDENWALD (Baltimore): I would like to call attention to 4 cases of acute pancreatitis reported by Doctor Thomas S. Cullen and myself. In our publication we followed the classification of Fitz as to the three forms: hemorrhagic, gangrenous and suppurative. These really represent various stages of the same process which begins as the acute hemorrhagic lesion.

The first case was in a diabetic patient with gallstones and acute nephritis. The patient

was a female sixty-seven years of age. She was suddenly attacked with pain in the umbilical region, followed by continuous vomiting and was in a state of extreme shock. There was marked abdominal distention, rigidity and extreme tenderness, and a leucocyte count of 26,000. At operation a quart of bloody fluid was found in the abdomen and fat necrosis was extensive. The gall bladder contained a few small stones. The patient died a few hours following operation.

The second case also occurred in a patient affected with cholelithiasis. The patient, a female of twenty-four years, had had numerous attacks of typical gallstone colic. She had been pregnant and had gone through a normal confinement two weeks prior to her entrance into the hospital. She was suddenly taken with acute abdominal pain in the region of the gall bladder with vomiting and obstinate constipation. On entering, she was in a state of shock with rapid pulse and subnormal temperature. The abdomen was distended and rigid. A diagnosis of cholelithiasis with perforation was made and immediate operation advised. On entering the abdomen a serous fluid was encountered and milky patches of fat necrosis noted in the omentum and peritoneum. The gall bladder was enlarged and contained from 30 to 40 mulberry-like stones; the gall bladder was drained and the patient made a satisfactory recovery.

The third case was also in a patient with cholelithiasis. She was a female of sixty years who had been affected for many years with attacks of indigestion occurring at irregular intervals following meals. She was suddenly seized with violent epigastric pain, nausea and vomiting. She entered the hospital in a state of shock. The abdomen moved but slightly in inspiration and the walls were rigid and there was extreme tenderness under the right costal arch and in the epigastrium. The leucocyte count was 22,700. On opening of the abdomen a turbid, reddish fluid escaped containing many small flakes. The omentum contained numerous small areas of fat necrosis. The gall bladder was drained and contained one large stone and several small ones. The patient had a stormy convalescence but was discharged after six weeks in good condition.

The fourth case was one of acute pancreatitis with gallstones and subsequent abscess formation. This occurred in a female thirty-four

years of age; who had complained of a mild gnawing pain in the upper abdomen at irregular intervals; which recently had become more frequent and intense, requiring morphia for relief. She was admitted to the hospital with extreme abdominal pain and the diagnosis of cholelithiasis made. On opening the abdomen small whitish areas were noted scattered over the surface of the omentum. The pancreas was found much enlarged and the fat presented numerous areas of necrosis. The gall bladder was drained and three stones removed. Following operation, the patient was in extreme shock and the outlook seemed poor. The patient, however, recovered from the immediate effect of the operation, but the temperature began to rise about the third week and she vomited continuously. She lost ground, could not retain food, became weak and drained profusely. On the twenty-first day a definite mass could be detected about the lower third of the gall bladder incision. This was found to be the wall of an abscess cavity which was drained and finally healed and the patient made a good recovery. Of our four cases, all were affected with gallstones and three of the four recovered.

DR. ARTHUR C. CLASEN (Kansas City Mo.): Those of us who have seen many cases of acute hemorrhagic pancreatitis in the experimental animal are amazed at the rapidity in which death takes place, namely: six to twenty-four hours in spite of all therapeutic measures both surgical and medical. The cause of this exodus makes one speculate somewhat.

Generally there is present a large amount of sanguinous fluid in the peritoneum often without visible fat necrosis or gross liver or kidney change; only a portion of the pancreas may show evidence of the large hemorrhage or a well-formed clot without evidence of recent bleeding; yet the remaining portion of the pancreas may appear perfectly normal. Death in these animals probably is not due to the profound anemia produced or to the external pancreatic secretion. We have noted definite changes in the blood chemistry of these animals; some showed marked increase in the urea, non-protein nitrogen and carbon dioxide with a definite fall in the blood chlorides and sugar resembling those changes noted in high intestinal obstruction as discussed by Doctors Orr and Hayden; again other cases show

(Continued on page 522)

UNUSUAL AND COMMON FORMS OF BACTERIAL DYSENTERY OBSERVED IN THE SOUTH*

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NEW ORLEANS, LA.

IN a seven year survey of the dysentery cases due to bacteria occurring in the extreme Southern section of the United States, we have had the opportunity to study clinically and bacteriologically approximately 100 cases. As a result of these investigations there are sufficient data to confirm the findings expressed by other Southern observers and the previous reports of ourselves. That is, bacillary dysentery is endemic and apparently on the increase in some states. We are also enabled to make the first report from the South of cases of bacillary dysentery due to the bacillus of Duval and the second in the States since the discovery of the organism in 1904. Another purpose of this communication is to include descriptions of cases that represent certain unusual types of bacterial dysentery encountered in the present study.

First with brief references to the incidence of acute and chronic bacillary dysentery, we agree with Boyd,¹ who in 1921 expressed the belief that bacillary dysentery is too often overlooked. That writer made a plea for concerted effort in recognizing this form of dysentery. Boyd reported 2 cases of the disease occurring in Texas and showed that the Flexner and Hiss-Y bacilli were present and that contamination was taking place through the medium of the carrier.

In 1926,² a small group of cases, originating in Louisiana and due to the Flexner bacillus, was reported by one of us.

Ashworth, Upchurch and Straus³ in 1926 and Higgins⁴ in 1928 described bacillary dysentery in Virginia. The latter expressed the thought that the disease is apparently on the increase in that State.

DIAGNOSIS

An acute bacterial dysentery, which is in the great majority of instances one of the bacillary group, is initiated by sudden and generalized abdominal cramps with a rise in temperature. Several hours and sometimes one or two days may elapse before the onset of diarrhea. The individual may show marked signs of toxemia, especially preceding the bowel eliminations. Following the passage of retained feces, the stools are characterized by bloody mucus which on microscopic examination contains much pus but no *Amoeba histolytica* except in the mixed infection. There is more difficulty in the recognition of the chronic and low grade state of bacillary dysentery. The chronic case may or may not have had its onset in the acute symptoms. There may be only an occasional diarrhea and at times an alternating constipation. The stools are soft to watery, containing mucus and are rarely blood tinged. In the temperate climes, the Flexner bacillus infection is predominate and the chronic cases are mild, sometimes very severe in the acute stage and not infrequently fatal in children. Infection with the Shiga bacillus is nearly always a serious affair, occasionally seen in temperate climes but usually met with in the tropics. The stools may number 15 to 25 per diem even in the mild acute cases, and there is considerable rectal disturbance.

The presence of many pus cells as well as endothelial cells in a stained smear of dysentery stools is in itself a valuable differential diagnostic sign favoring the bacillary rather than the amebic type of infection. Stitt⁵ describes this smear as

* Read before the American Gastro-Enterological Association, Atlantic City, N. J., May 4 and 5, 1931.

75 per cent polymorphonuclears showing signs of degeneration but at times these cells simulate a fresh pus smear.

The proctoscopic examination is a valuable aid in diagnosis of the acute case of dysentery. The mucous membrane is usually extensively but superficially ulcerated. These ulcers bleed and the surrounding mucous membrane is highly inflamed and presents a granular appearance. In the chronic case the mucous membrane may show no ulcers but there is a granulation tissue replacement and considerable hyperemia.

The diagnosis of bacillary dysentery is generally made on the blood serum agglutination test, it being difficult to isolate the causative organism except in the best equipped bacteriological laboratory, especially in the chronic cases. The agglutination reaction alone will carry with it more or less limited diagnostic significance dependent on the dilution of the agglutinating serum and the type of organism being tested. For example, with the Shiga bacillus it is considered diagnostic if the blood serum completely agglutinates in a low dilution of 1:50. With the Flexner bacillus, it is necessary to obtain agglutination in dilution up to 1:100.

Within the first few days of an acute bacillary dysentery, the agglutinins may not develop.

Cultures are of paramount importance in the diagnosis of bacterial dysentery. In the bacillary types, positive cultures are more frequently obtained from rectal contents and especially ulcer scrapings than from stool specimens. Delay in the examinations of stools accounts for many negative results. Fletcher and Jepps⁶ demonstrated that the Shiga bacillus in acute dysentery will disappear from the stools within twenty-four hours in 10 out of 15 cases; in 4 they were present on the second day, and in one they survived until the third. The Flexner bacillus lived considerably longer, in the feces, than the Shiga type of organism. In more than half the specimens, 36 in number, the

bacilli persisted for more than a week. In most of the specimens, the organisms were not found at every examination which was made during the time they remained alive in the feces; the reason for this was a sudden drop in the proportion of dysentery bacilli during the first thirty-six hours. This shows how important it is that bacteriological examinations be made with as little delay as possible.

Out of the 100 cases of bacterial dysentery seen by us, the predominating type is the bacillary. In the latter group the prevalent strain of infecting organism is the Flexner bacillus. About 75 cases of acute and chronic Flexner infections of the bowel were observed. The other bacilli of dysentery isolated from individual cases were the Shiga, the Duval and the Morgan. There undoubtedly are other cases of dysentery, not belonging to the bacillary or the amebic group, that are caused by bacteria and that are quite often unrecognized.

With reference to the unusual forms of bacterial dysentery, examples of which are herein described, it is our opinion that these are sometimes secondary to true dysentery.

DUVAL BACILLUS DYSENTERY

Since the discovery in 1904 of the lactose fermenting bacillus of dysentery by Duval and Schorer,⁷ cases of dysentery due to this strain have been little seen in this country. Following the isolation of the organism from infants during an epidemic, Duval⁸ isolated a similar strain from the contents and scrapings of the gut in a fatal case of dysentery in an adult. In 1905, Torrey⁹ reported the finding of similar microorganisms in the stools of infants with diarrhea. Although several in question died, he would not admit an etiological relationship, because in the few instances in which the test could be done, the patient's serum either failed to agglutinate the bacillus or did so in low dilution only.

Simultaneous with our own investigations,¹⁰ Nelson¹¹ studied cases of diarrhea in the Boston Children's and Infants'

Hospital during a period of six months. There were 32 cases reported as caused by *Eberthella paradysentery* Sonne. This late lactose fermenter is identical with the bacillus isolated by Duval and Schorer.⁷

While our group of cases in which this bacillus was isolated numbers only 5, they are reported for several reasons. First, there is an infrequency of the infection in this country, and these five represent the only ones studied in the South. There is no previous record of the disease occurring in several sporadic instances in the same locality. Of our 5 cases, 4 were in children under five years of age and only one in an adult. The bacillus of Duval was recovered from the rectal smear in each instance, and the patient's blood agglutinated the organism. The dilutions of the serum ran from 1:30 in one case and up to 1:200 in another. Of particular interest was the fact that the sera of these patients agglutinated the stock culture of the original strain isolated by Duval in 1904.

The symptoms in these cases were acute. The rectal mucous membrane showed numerous ulcers in each person. However, they ran a short course of a few days to one and one-half weeks' duration. The disease was mild and definitely self limited, which is unlike the dysentery produced by strains of Shiga and of Flexner bacilli that carry a high mortality in early childhood and with some tendency to become chronic in the adult.

CHRONIC STREPTOCOCCAL DYSENTERY

While different strains of streptococci are frequently found in the human intestinal tract, it is extremely rare to encounter a case of dysentery due to this organism. Bassler¹² names and discusses sixteen different varieties of intestinal streptococci that are more or less of pathogenic significance in connection with intestinal toxemia, the gut acting as a source of focal infection and especially as a source of toxin absorption. He believes the streptococcus represents the most important infecting organism in the intestinal

canal and requires much attention in the examination of stools. However, this author does not cite any cases or does he refer to the possibility of the streptococci being the etiological factor in dysentery. In fact, we find that the literature for the past twenty-five years is practically devoid of any such references. For these reasons and because of the results of treatment, the following case of chronic streptococcal dysentery is reported:

Miss E. L. was first seen November, 1929, at the age of twelve. For the previous three months, she has been having frequent bowel movements (25 in twenty-four hours). The temperature rose to 102°–104°F. The stools contained mucus, some blood and purulent material. Frequent cross abdominal pains were present. A previous history was given of jaundice six years previous and pyelitis preceding.

The physical examination showed a well-developed but somewhat undernourished child. The head, including pupillary reflexes, throat, thyroid and lymph glands were normal. The tonsils had been removed.

The chest examination was negative, including skiagraph.

Abdomen: The liver was easily palpated on inspiration. There was no tenderness on pressure.

Reflexes were normal.

Laboratory Examinations: The urine showed a few pus cells. Gastric analysis (after test-breakfast) showed normal gastric digestion, pH 1.8. Repeated microscopic examinations of stools failed to show any amebae, or other protozoa. Stools contained mucus and some pus.

Blood pictures:

11/3/29	11/8/29	11/11/29
Reds		
5,975,000		
Whites		
16,250	10,250	7500
Hemoglobin		
85 per cent		
N. 48 per cent	N. 67 per cent	N. 57 per cent
S. M. 48 per cent	S. M. 31 per cent	S. M. 42 per cent
L. 4 per cent	L. M. 4 per cent	L. M. 1 per cent

Blood serum agglutination test for bacillary dysentery was positive in dilution 1:60 for Flexner bacillus. The Mantoux intracutaneous tuberculin test was negative.

The bacteriological examination of the stool revealed a very unusual finding of a pure culture of streptococci, there being no colonies of colon or other bacteria.

The patient's blood serum agglutinated this strain of streptococcus in dilution as high as 1:620. All other common strains of streptococci grown in the laboratory showed negative agglutination with the patient's serum.

The proctoscopic examination showed no ulcers or other rectal pathology. The barium enema examination showed normal haustrations of the colon.

From November, 1929, to May, 1930, very little improvement was noted. A high calorie non-irritating diet with colonic irrigations of acriflavine and other antiseptic solutions had been given during this period.

On May 5, 1930, an autogenous vaccine made with the strain of streptococcus isolated from the patient's stool was administered subcutaneously for the first time. From that date, when the stools numbered 8 to 12 in twenty-four hours and the patient weighed 60 pounds, until December 7, 1930 (a seven months' period), doses of the vaccine varying from 0.1 c.c. to 2 c.c., the large dose being followed by severe systemic reaction, were administered subcutaneously every three to four days. The improvement was marked with a decrease in the number of stools to 3 or 4 in twenty-four hours, with most of them formed, and a gain in weight of 20 pounds. A culture of the stool in September, 1930 (four months after vaccine therapy was started) showed a predominance of colonies of the same streptococci (serologically determined) and a return of the colon bacilli to the flora. Autogenous vaccine therapy has been continued and at the present writing the patient averages three firm stools a day with an occasional rise in temperature to 99.2°F.

CHRONIC SALMONELLA ENTERITIDIS INFECTION

Since the discovery of the *Bacillus enteritidis* by Gaertner in cases of meat poisoning, acute bowel infections due to this organism have been reported from nearly all parts of the world.

In a recent report from New Orleans, D'Aunoy¹³ discussed the progress of several acute cases that were infected through the ingestion of cream-filled confections. It is noteworthy in his discussion that the immune bodies (agglutinins) disappeared from the blood within ten days after recovery. All of his cases recovered.

Under incidence, Bassler¹² states that *Salmonella enteritidis* is practically never found in chronic intestinal infection, usually only in meat poisoning from the use of infected meats from cattle.

The following case, encountered in our study of the bacterial dysenteries, represents the unusual occurrence of a chronic *Salmonella enteritidis* infection.

A dentist, seventy years of age, was first seen on August 8, 1930. For six months he had from 10 to 20 liquid stools per diem throughout the day and night. He felt a continuous pain in the right lower abdomen and a similar distress at times in the left.

Nothing of note was found on physical examination.

The gastric analysis showed a normal acidity.

Sigmoidoscopic examinations revealed a diffusely injected rectal and sigmoid mucous membrane and a bloody mucous secretion in the lumen. Cultures of this material contained many colonies of *Bacillus enteritidis*. The patient's blood serum completely agglutinated this strain in dilution 1:60. The other members of the colon-typhoid group were not agglutinated. For nine months, the infection has persisted and the low grade chronic dysentery has been refractory to autogenous vaccine, foreign protein and other therapy. Withal the patient has gained 22 pounds on a high calorie non-residue diet.

STREPTOBACILLUS ASSOCIATED WITH CHRONIC DYSENTERY AND PYELOCYSTITIS

A married woman, aged thirty-seven, was seen on July 28, 1928. During a period of five years she suffered with abdominal distention and generalized abdominal pain, the bowels moving three to five times daily of a watery consistency. Raw fruits and sweets would cause a profuse diarrhea. Temperature

would rise in the evening to 99° and sometimes 100°F.

The physical examination of the head and chest was negative. The abdomen was generally sensitive to light pressure and quite painful in the left hypogastrium.

The pelvic examination was negative.

The rectal mucous was diffusely injected and inflamed.

The stool culture showed numerous colonies of a gram-negative, non-fermenting streptobacillus. The patient's blood serum completely agglutinated these organisms in dilution up to 1:80. There was a development of bladder symptoms, painful and frequent urination. Cultures of the catheterized specimens and right kidney urines were positive for the same non-fermenting streptobacillus isolated from the stools. The blood serum of the patient completely agglutinated the urinary organisms in 1:80 dilutions.

The bacillus of dysentery has been known to produce urinary tract complications. This is rare. In the instance of the colon bacillus infecting the kidneys and bladder, many authorities are of the opinion that the bacillus always migrates from the intestinal canal.

SUMMARY AND CONCLUSIONS

Several varieties of bacterial dysentery have been encountered in a survey of approximately 100 cases of this disease. The bacillary types, especially the strains of Flexner, Shiga and Duval, are endemic in the South and appear to be increasing in incidence. Recent reports from northern sections of the country would warrant careful investigation of suspicious cases for the possible determination of a wider dissemination of bacillary dysentery than is at present suspected.

Several unusual types of bacterial dysentery, in some instances with few previous clinical or bacteriological descriptions, are found to exist in the South.

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DISCUSSION

DR. ASHER WINKELSTEIN (New York): In our climate, we find that chronic cases with bloody diarrheas, with or without fever, are usually instances of so-called non-specific ulcerative colitis. The old dispute has been going on for many years as to whether non-specific ulcerative colitis is or is not acute or chronic bacillary dysentery. In favor of the view that it is, is that the clinical, sigmoidoscopic, and, pathologic features certainly resemble very strongly, and in many cases possess the identical features of bacillary dysentery. However, the bacteriologic and serological evidence for this point of view has been lacking. Thorlaksen of Canada reported 4 cases that were considered typical non-specific ulcerative colitis in which he recovered the dysentery organisms.

The studies that are usually made are not sufficient to answer that question. To get a positive culture in bacillary dysentery it is necessary to take the culture from very fresh stools. If the stool is carried from the patient's bedside to the laboratory a half a block away one may miss a positive culture. It is very important to take repeated cultures of freshly passed stools. The agglutination reaction does not help as a rule. In our experience we have hardly ever, except in the special exceptions which I will mention, got a positive agglutination. Agglutinins often do not appear, particularly in the acute stages of disease and sometimes not even in the chronic.

At Mount Sinai Hospital in the last six months by careful bacteriologic investigation we have been able to prove, I think quite conclusively, that 4 cases of non-specific ulcerative colitis were definite bacillary dysentery, three Flexner, one Shiga. The patients all had the organism and all had positive agglutinations and the cross-absorption tests were confirmatory. We feel because of this and some other investigations which are in progress, particularly by means of bacteriophage studies, that non-specific ulcerative colitis is, in a certain number of the instances, what percentage we do not know as yet, bacillary dysentery either at the beginning or chronically so. And that, of course, is extremely important because of the isolation of a definite group and for the specific therapy.

Hurst, as you know, in England, and Crohn, in this country, have been ardent advocates of the polyvalent antidysentery serum. Occasional good results do not, of course, prove anything about the nature of the disease. We have treated several cases with the bacteriophage for the specific dysentery organism which was present or thought to be present. From a limited experience, we are not able to state definitely as to what the results are. All of us who see non-specific ulcerative colitis ought to study with the greatest care the bacteriology of the stools, particularly the very fresh specimens; and make repeated serologic tests with the point of view in mind that some of the cases of non-specific ulcerative colitis may be bacillary dysentery.

DR. MOSES PAULSON (Baltimore): I am particularly interested in this streptococcal type of dysentery described by Dr. Silverman. The claim that streptococci are responsible for some type of dysentery is not new. With the intestine harboring myriads of organisms, it has not seemed possible to accept statements of the finding of a pure culture of one organism inhabiting an extensive area of involved bowel to the exclusion of all of the others. In five or six years' experience in the study of diarrheas in an experimental laboratory, I have never encountered a pure culture of any one organism. Frequently one sees in the literature the statement of the encountering of "almost a pure culture" in dysentery. "Almost a pure culture" of this or that organism, bacteriologically speaking, is not a pure culture. In many dysenteries the abundant growth of one organism

at the expense of others in culture media favorable to the growth of that particular abundant bacterium, is not to be confounded with the actual bacteriologic state of affairs in the bowel proper; for example: certain cultural media may favor the growth of streptococci, yet streptococci may not be found to predominate in smears taken directly from the intestine. And again, in different cultural media, from material from the same source, another type of bacterium may preponderate.

However, in this instance, Dr. Silverman may have established his point. The bacteriological work appears to have been done very carefully, and the agglutination studies with the streptococci isolated are suggestive. I say suggestive because agglutination studies with streptococci are not satisfactory. These organisms, in the main, present poor antigenic properties, produce poor agglutination sera, and many of them even agglutinate spontaneously. The methods used to differentiate actual from spontaneous agglutination are not very satisfactory. I note that Dr. Silverman made efforts to overcome these difficulties in that he states that the streptococci alleged to be the etiologic agent in the type of dysentery he described, did not agglutinate in normal sera but did agglutinate in the patient's serum.

I cannot say that I am particularly impressed with the reported efficacy of vaccine therapy in the streptococcal type of dysentery. It is to be noted that the patient secured a remission upon the administration of vaccine after three or four months. Most of these cases secure more or less of a complete remission within this very period of time without vaccine. Remissions in many instances are spontaneous, I think, for they occur often regardless of the type of management and in spite of anything one might do.

Finally, it might be pointed out that the proctosigmoidoscopic pictures in organic diarrheas are not pathognomonic of any one intestinal involvement for we have seen cases both of amebic and bacillary dysentery which have presented appearances not unlike that of non-specific, or idiopathic ulcerative colitis.

DR. T. R. BROWN (Baltimore): Dr. Silverman brought up so many points of importance that I must say a few words about certain of those points.

In the first place, the practical point that the sigmoidoscope should be essential equipment in all diagnostic procedure to all clinicians; it adds so much to our knowledge.

In the second place, the extreme importance of making our studies, where possible, by means of fresh smears studied is the warm stage which increases tremendously the possibility or probability of finding the offending organism.

In the third place, the fact that the sigmoidoscopic picture as described by Dr. Silverman is very little different from that frequently described in certain cases of so-called non-specific ulcerative colitis, which calls attention to the fact it is not possible in every case to make a differential diagnosis between the two conditions.

In the fourth place, the very interesting case of streptococcal infection because it brings to the fore the moot question of whether streptococci can do this. I think Dr. Silverman has proved his case and yet in the great majority of cases we must take so-called streptococcal infection with many grains of salt.

The last point and the point I wish to ask Dr. Silverman's advice about is: in the treatment of these cases of bacillary dysentery, has he had results from serological treatment? Has he had results from vaccine therapy or has he followed the lead of certain of the workers in the Pasteur Institute and certain pediatricists in France, and found that this is one group of cases in which the bacteriophage has been effective.

DR. LEON BLOCH (Chicago): In all the patients in whom the diagnosis of ulcerative colitis is made, complete bacteriological and agglutination tests are carried out. In quite a few, the laboratory reported that streptococci were found and occasionally in pure cultures. We have made attempts to use a form of vaccine but met with failure in every case. In 5 of these patients positive agglutination tests with the Shiga bacillus were obtained. Four of these were acute cases. They started in the Fall after the patients had come back from a vacation in Southern Michigan. All had fifteen to twenty stools a day, typical mucopurulent stools of bacillary dysentery type. One of them had had a colostomy done a month before we saw him. He came into the hospital in a moribund condition and died from a perforation of the bowel before anything could be done. The 3 others in whom the diagnosis of

bacillary dysentery had been made were treated with Flexner polyvalent antidysentery serum. Within the first twenty-four hours the number of stools dropped from fifteen and twenty to three or four and within forty-eight hours the stools had become partially formed. Two patients, sisters, one eighteen and one twenty, who had contracted the disease at the same time left the hospital after one week's stay with complete disappearance of all symptoms. In an other, a child who had been sick quite a while before she entered the hospital, the number of stools was reduced from twenty-five a day to ten a day after the first administration of the serum.

I call attention to these points because I believe that a good many of these patients who come to the hospital with a diagnosis of non-specific ulcerative colitis may have had a bacillary infection to begin with and subsequently a superinfection with whatever is the cause of the non-specific ulcerative colitis.

DR. B. B. CROHN (New York): I should like to note that this festering sore of the causation of non-specific ulcerative colitis comes up again and again before the Association. If it is becoming apparent that dysentery organisms may be found in New York, are found in Chicago and are very definitely found in the South, it looks as if it would be likely that we will have to take out of the category of non-specific ulcerative colitis a certain percentage of cases, possibly only a small percentage, and group them possibly with the true dysentery cases.

I personally have been using polyvalent antidysentery serum since 1922, the idea originating first with Hearst in London. And I must say that I achieve in some of the cases very striking results, extremely striking. I never have been able to determine in my mind whether it is a non-specific result or a specific result though personally I have always felt the result was achieved through the non-specific protein of the serum rather than any specific effect of serum on possible existence of dysentery organisms in the body. However, I should like to encourage the use of polyvalent antidysentery serum and incidentally to ask Dr. Silverman, who has been handling these cases, just what his routine has been in the treatment of cases: whether he used the serum intravenously or intramuscularly; and to repeat the question of Dr. Brown as to the use of bacterio-

phage, because, if it is to be efficacious in any type of disease, it surely should be efficacious in this particular bacillary intestinal malady.

DR. DANIEL N. SILVERMAN (*Closing*): With reference to the treatment of bacillary dysentery I said very little because of the discouraging results that are reported and which we have had. I think the only favorable results we have been able to obtain in acute cases of Flexner dysentery with polyvalent antidyentery serum, we have given from 30 to 60 c.c. daily intramuscularly for the first four or five days.

With reference to vaccine therapy, Fletcher and Jepps in the Federated Malay States have had probably the largest series of bacillary dysentery in recent years and they are of the same opinion: that vaccine therapy is of no avail in the acute or the chronic cases of bacillary dysentery.

The bacteriological study is of great importance in the diagnosis of bacillary dysentery for the reason that we cannot depend absolutely upon the agglutinins, not only as to the type, but whether or not they are present, for this reason; that Lacy in the Philippines showed that there were some sixty different strains of Shiga organisms (I am sure there must be many of the Flexner bacillus) and the fact that we have been getting negative agglutinations in some of our cases, and that we suspected bacillary dysentery, led us on to more thorough cultural studies of bowel contents and we found Duval bacillus was present in some of our cases. So I think unless we have bacteriological studies, it is very difficult at best to make a positive diagnosis.

I have had no experience with the bacteriophage.



DISCUSSION OF DR JONES*

definite increase in urea, non-protein nitrogen and sugar without chloride or CO₂ change resembling the blood findings in experimentally produced peritonitis.

Upon a microscopic examination of the tissues of these animals, one is impressed with the tremendous changes noted in the liver and sometimes in the kidneys with definite areas in the pancreas which appear practically normal. The hepatic changes seem to run parallel with the blood chemical findings more than do the pancreatic changes. This suggests the cause of death as being due to

an hepatorenal complex rather than to shock or peritonitis with tryptic digestion.

DR. CLEMENT R. JONES (*closing*): I have nothing further to say except to again call attention to the fact that the treatment in all of these cases is surgical and that I believe there are really two distinct varieties of this trouble: that which is caused by traumatism, whether the traumatism comes by pressure from within or whether it comes by injury from without or by the apoplexy of the gland as reported by Dr. Opie; and the infective inflammatory type caused by hematogenous or extending infection.

* Continued from p. 514.

STUDIES IN GASTRIC SECRETION

WITH A PRELIMINARY NOTE ON A NEW METHOD OF THERAPY FOR PEPTIC ULCER*

ASHER WINKELSTEIN, M.D.

NEW YORK CITY

APPARENTLY the three most important factors in the problem of the pathogenesis of peptic ulcer are (1) form achlorhydria in the group of humans in whom Dr. Berg carried out this procedure.

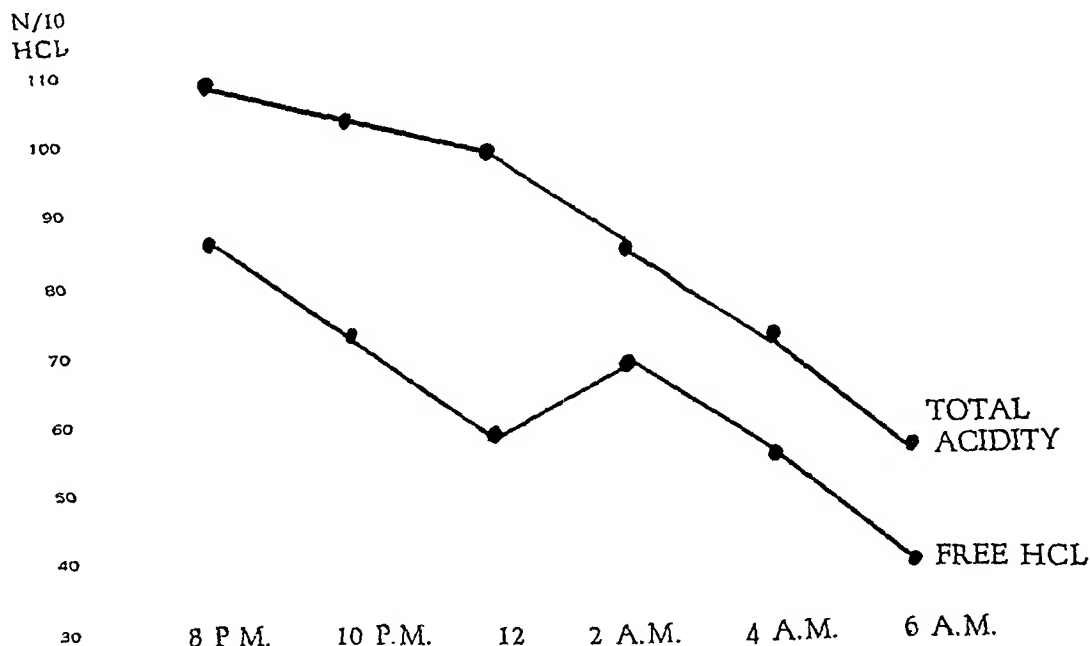


FIG. 1. Composite curve, "night Refhuss," 12 duodenal ulcer patients.

the mechanical factor, (2) the acid factor and (3) the tissue susceptibility.

As you know, in recent years, we have been particularly interested at Mount Sinai Hospital in the second, or acid, factor. Three years ago, before this Society, Dr. A. A. Berg presented the results of partial gastrectomy for ulcer, emphasizing the importance of subacidity or anacidity in the excellent results and particularly in the prevention of recurrence. At the same meeting I demonstrated, by means of pharmacologic studies, that the vagus nerve played an especially important rôle in the hypersecretion of ulcer patients. Dr. Eugene Klein then advocated the addition of left vagus nerve section to partial gastrectomy; with a resultant uni-

Because of the importance of the vagus nerve in the mechanism of acid production, we have devised special test meal studies. Among them, it occurred to me to study the night secretion, i.e., the inter-digestive, fasting, or continuous phase of gastric secretion, presumably vagal in origin. At 4.30 P.M. the patient ate a light supper consisting of milk, eggs, toast and butter, and stewed fruit. The Rehfuß tube was passed into the stomach at 7 P.M. and a sample aspirated every two hours during the night. The patients usually slept fairly well. The illustrations show the results. In the first (Fig. 1), in duodenal ulcer, you see a high continuous curve; in the second (Fig. 2) in gastric ulcer, a moderate curve; in the third (Fig. 3) in the control

* Read before the American Gastro-Enterological Association, Atlantic City, N. J., May 4 and 5, 1931.

group, a very low one. In fact, four of the six controls did not show any free hydrochloric acid during the night and only 1

tinuous, twenty-four-hour daily, Murphy drip, through a Rehfuß tube, of alkalized milk into the stomach in duodenal ulcer,

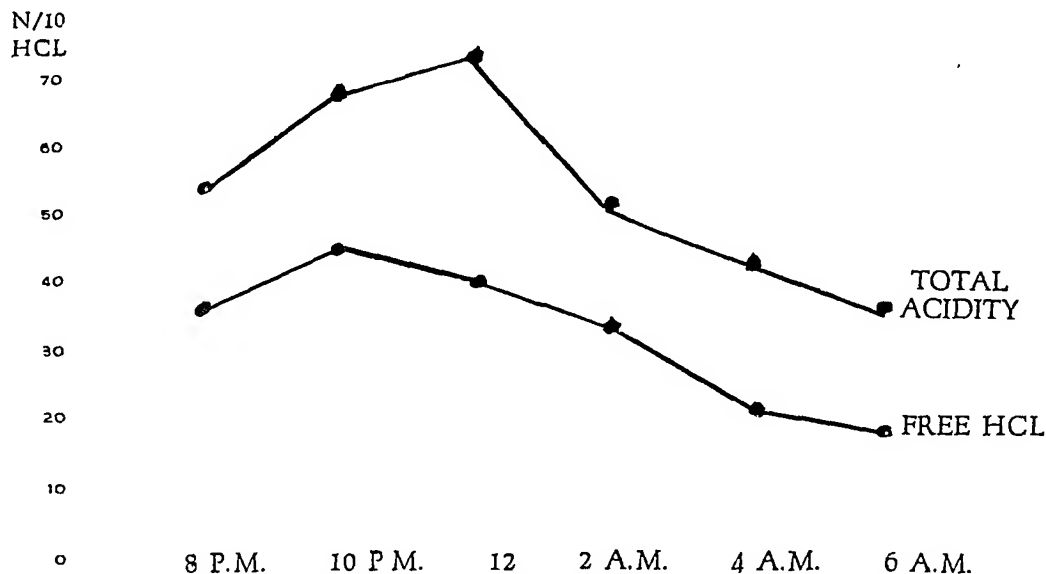


FIG. 2. Composite curve, "night Rehfuß," 5 gastric ulcer patients.

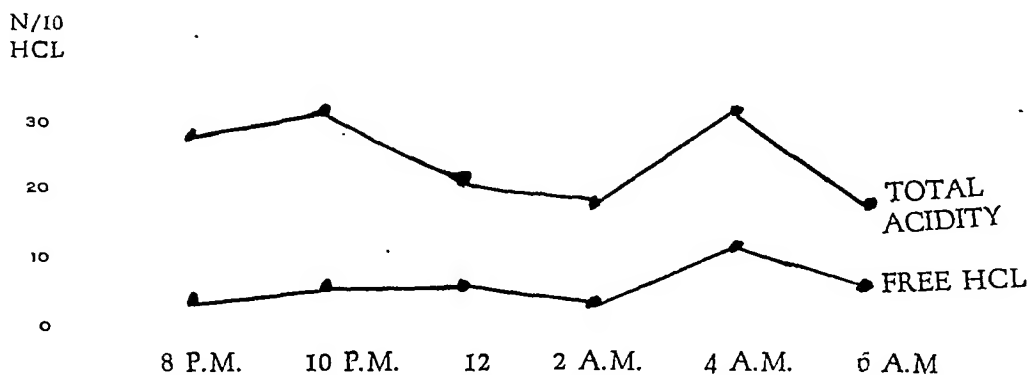


FIG. 3. Composite curve, "night Rehfuß," 6 control cases.

or 2 c.c. of gastric contents.

The theoretical significance of this cannot be discussed here because of the limitation of space. Practically, on the basis of this and other studies and also on theoretical grounds, I have suggested a new therapy of ulcer. This consists of a con-

tinuous, twenty-four-hour daily, Murphy drip, through a Rehfuß tube, of alkalized milk into the stomach in duodenal ulcer, and in jejunal ulcer. The details of the treatment must be omitted because of the lack of space. It may be said, however, that 12 patients with ulcer have been treated in the past few months and the method is definitely practicable and seems promising.



COMBINED ORAL & INTRAVENOUS CHOLECYSTOGRAPHY*

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BOSTON

CHOLECYSTOGRAPHY, since its introduction in 1924, has been practiced with varying degrees of entirely on that notoriously capricious modification, the oral method. The work to be reported in this paper



FIG. 1. Shadow (before meal) of average density, as obtained by combined method.



FIG. 2. Same case as Figure 1, after fat meal.

success. Like many laboratory methods, it may be very helpful when interpreted in the light of clinical data, but quite misleading when its results are used as the only criteria. One of us has used cholecystography since its introduction and has found it decidedly helpful when the morphological and physiological data are considered in terms of the clinical history. A large part of the disrepute in which the method stands now has been brought upon it by observers who rely

concerns only ambulatory cases, and comes from two sources: a private office and an out-patient gastrointestinal clinic. Before the adoption of the combined method, it was the practice in the private office to use the intravenous method immediately in the study of all cases with definite gallbladder histories, as it seemed that suggestive pathology by the oral method meant very little; patients with other digestive symptoms were examined first by the oral method, and, in the event of an unsatisfactory test, were checked by the

* From the Gastro-Intestinal Clinic, Department of Medicine, Boston Dispensary. Read before the meeting of The American Gastro-enterological Association, Atlantic City, N. J., May 5, 1931.

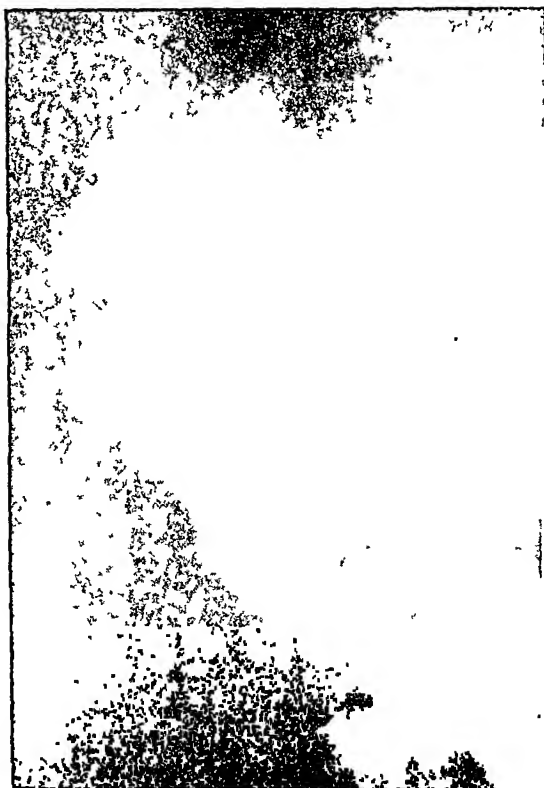


FIG. 3. Cholecystogram (before fat meal) by combined method; two previous oral tests gave no filling.



FIG. 4. Same case as Figure 3, after fat meal.



FIG. 5. Negative shadow demonstrated by combined method, (before meal)



FIG. 6. Same case as Figure 5, after fat meal.

intravenous method. Infection, allergy, cardiac decompensation and coronary disease were usually looked upon as contraindications to the intravenous test. The hospital out-patients were all examined by the oral method; if the filling was not satisfactory, another test was done by the oral method, the supposition being that inability to fill on the two oral tests meant a pathological condition.

Since July, 1928, one of us, at the suggestion of Dr. L. R. Whitaker, has used a method which combines the usefulness of the oral method for ambulatory cases and the definiteness of the intravenous. In this method we give an intravenous dose sufficient to visualize the gallbladder, but small enough to eliminate reactions and hospitalization, and half the oral dose for fortification of the shadow. It was felt that if this method would eliminate hospitalization and present accuracy comparable to that obtained by the intravenous method, it would be particularly advantageous for ambulatory patients.

METHOD

On the day before the x-ray examination the patient eats a light low-fat supper at 4 P.M. and reports for the intravenous injection at 5 P.M. With the patient lying flat on his back, 1.5 gm. of sodium tetraiodophenolphthalein dissolved in 35 c.c. of distilled water, filtered and sterilized, are injected over a period of five minutes; the patient remains in this position for one-half hour before leaving the office. At 7 P.M. one-half the usual oral dose is taken in the usual way (keraphen, shadocol, and tetradol have been used); the patient is advised to rest during the evening and takes no food until after the x-ray examinations. The hospital patients received their oral doses before leaving, in order to eliminate misunderstanding.

At 9:30 A.M. the next day films are taken in the usual way, and, if satis-

factory, the patient eats a fat meal. One hour after the fat meal, films are taken again; if the gallbladder has not con-



FIG 7 Negative shadows demonstrated by combined method.

tracted to at least half its size, further films are taken at intervals.

RESULTS

The results in 100 office cases with digestive symptoms not suggestive of definite gall-bladder disease, by our former procedure, of first the oral method, and, in the event of no shadow, a subsequent intravenous test, are recorded in Table I.

The results in 115 digestive (unselected) office cases studied by the combined method are shown in Table II.

Table III records the results in 50 consecutive hospital cases examined by the oral method and by another oral test (in a few instances by combined method).

The results in 50 consecutive hospital cases studied by the combined method appear in Table IV.

TABLE I

ORAL METHOD IN OFFICE PRACTICE

Used routinely in cases without definite gall-bladder symptoms
(Definite cases were done by the intravenous method)

(Note: When no shadow was obtained, checked by intravenous test)

Case Number	Sex	Age	Weight	Clinical Picture			First Examination Filling		Repeat Examination Filling	
				Typical Gall Bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	By Oral Method		By Intravenous Method	
								*Density (before Fat Meal)		Density (before Fat Meal)
1	F	28	152	..	+	.....	+	A		
2	M	29	140	..	+	.....	+	B		
3	M	46	140	..	..	Ulcer	+	B—		
4	M	27	144	..	+	.....	o	o	+	A
5	M	32	172	..	+	.....	+	B		
6	F	47	134	..	..	Colitis	+	D		
7	F	56	140	..	+	.....	+	D		
8	F	52	137	+	..	.....	o	o	Negative shadows +	D
9	F	36	138	..	+	.....	o	o	+	A
10	F	52	165	..	+	.....	+	B		
11	F	39	121	..	+	.....	+	A		
12	F	53	152	..	+	.....	+	C		
13	M	51	160	..	+	.....	o	o	Not checked	
14	M	36	184	..	..	Ulcer	o	o	+	C
15	M	45	145	..	..	Ulcer	+	C		
16	M	42	178	..	+	.....	+	C		
17	M	61	153	..	+	.....	o	o	+	B
18	M	45	150	..	+	.....	+	C		
19	M	46	127	..	+	.....	+	B		
20	F	41	128	..	+	.....	+	D		
21	M	32	137	..	+	.....	o	o	+	B
22	M	50	155	..	+	.....	+	C		
23	F	32	142	..	+	.....	+	B		
24	M	42	155	..	..	Ulcer	+	C		
25	F	27	145	..	..	Migraine	+	D		
26	F	44	148	..	+	.....	+	D		

TABLE I (Continued)

Case Number	Sex	Age	Weight	Clinical Picture			First Examination Filling		Repeat Examination Filling	
				Typical Gall Bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	By Oral Method		By Intravenous Method	
								*Density (before Fat Meal)		Density (before Fat Meal)
27	F	63	127	..	..	Pernicious anemia	+	c		
28	F	36	131	..	+	.....	+	c		
29	M	30	191	..	..	Ulcer	+	D		
30	F	42	125	..	+	.....	+	D		
31	F	54	155	..	+	.....	+	c		
32	M	51	165	..	..	Abdominal pain of angina pectoris	o	o	+	B
33	M	35	135	..	+	.....	+	D		
34	M	41	145	..	+	.....	+	D		
35	F	18	89	..	..	Appendix	o	o	Not checked	
36	M	27	155	..	+	.....	+	c		
37	F	20	118	..	+	.....	+	D		
38	M	48	168	..	+	.....	o	o	o	o
39	M	36	147	..	+	.....	+	c		
40	M	49	143	..	..	.....	+	c		
41	F	20	146	..	+	.....	+	D		
42	F	45	132	..	+	.....	+	D		
43	F	50	169	..	+	.....	+	D		
44	M	30	105	..	+	.....	+	c		
45	M	29	167	..	..	Ulcer	+	c		
46	M	46	152	..	+	.....	+	c		
47	M	46	160	..	+	.....	+	A		
48	M	40	141	..	..	Digestive symptoms of cardiac failure	+	c		
49	M	32	124	..	..	Ulcer	+	c		
50	M	45	164	..	..	Ulcer	? Calculi	o	+	B

TABLE II
COMBINED METHOD IN OFFICE PRACTICE

Case Number	Sex	Age	Weight	Final Clinical Diagnosis	Clinical Picture			Cholecystograms				
					Typical Gall-bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Intensity and Reduction in Size (after Fat Meal)	Calculi	
1	F	43	135	Duodenal ulcer	..	+	.....	+	A	A $\frac{1}{3}$	o	
2	F	51	181	Duodenal ulcer	..	..	Ulcer	o	o	o	o	Note 1
3	M	40	174	Tuberculosis Hypertension	..	+	.....	+	B	B $\frac{1}{2}$	o	
4	M	30	149	Migraine	..	+	.....	+	B -	C $\frac{2}{3}$	o	
5	F	53	137	Mucous colitis (?) G.B. pathology	..	+	.....	+	A	A $\frac{1}{2}$	o	
6	F	68	109	Auricular fibrillation Gastric ulcer	..	+	.....	+	A	A $\frac{1}{3}$	o	
7	F	30	118	Appendix in R.U.Q. Chronic appendicitis	+	..	.....	+	B	C $\frac{1}{3}$	o	
8	M	35	191	Psychoneurosis	..	+	.....	+	C	C $\frac{1}{3}$	o	Note 2
9	F	43	157	Arthritis Spastic colon	..	+	.....	+	B	C $\frac{1}{3}$	o	
10	M	26	182	Anxiety neurosis	..	+	.....	+	B	o	o	
11	M	33	163	Sino-auricular block	..	+	.....	+	B	B $\frac{1}{3}$	o	
12	F	24	111	Pelvic pathology	..	..	Ulcer	+	A +	o	o	
13	M	26	159 $\frac{3}{4}$	Spastic colon Psychoneurosis	..	+	.....	+	C	D $\frac{1}{4}$	o	Note 2
14	F	37	141	Arthritis Endocrinopathy	..	+	.....	+	B	C $\frac{2}{3}$	o	
15	F	36	137	Cholelithiasis	..	+	.....	+	C	D	Negative shadows	Note 3
16	M	32	146	Gall-bladder pathology	+	..	.....	o	o	o	o	Note 3
17	F	43	89 $\frac{1}{4}$	Pulmonary tuberculosis	..	+	.....	+	B -	C $\frac{1}{4}$	o	
18	M	26	151 $\frac{1}{4}$	Renal calculus	..	..	Appendix	+	C	C $\frac{1}{3}$	o	
19	M	42	165	Duodenal ulcer	..	..	Ulcer	+	B	B $\frac{1}{4}$	o	
20	M	28	158	Duodenal ulcer	..	..	Ulcer	+	B	o	o	

TABLE II (Continued)

Case Number	Sex	Age	Weight	Final Clinical Diagnosis	Clinical Picture			Cholecystograms			
					Typical Gall-bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Intensity and Reduction in Size (after Fat Meal)	Calculi
21	F	45	181	Gall-bladder pathology	+	..	.....	o	No G.B. outline	No G.B. outline	Positive shadows
22	F	29	117	Psychoneurosis	..	+	.....	+	A	B $\frac{1}{4}$	o
23	F	37	154	Intestinal obstruction (partial)	..	+	.....	+	B	A $\frac{1}{3}$	o
24	F	43	121	Gall-bladder pathology	..	+	.....	o	o	o	o
25	F	45	144	Arthritis Spastic colon	..	..	.....	+	B	C $\frac{2}{3}$	o
26	M	62	141	Duodenal ulcer	..	+	.....	+	B	B $\frac{1}{4}$	o
27	M	43	173	Psychoneurosis	..	+	.....	+	B	C $\frac{1}{2}$	o
28	F	44	165	Duodenal ulcer	..	+	.....	+	B	B $\frac{1}{3}$	o
29	F	30	102	Spastic colon	..	..	Ulcer	+	A+	A+ $\frac{1}{5}$	o
30	F	34	131	Duodenal ulcer	..	+	.....	+	B	C $\frac{1}{2}$	o
31	F	35	123	Duodenal ulcer	..	..	Ulcer	+	C	B $\frac{1}{3}$	o
32	F	26	124 $\frac{1}{2}$	Duodenal ulcer	..	..	Ulcer	+	B	B $\frac{1}{3}$	o
33	M	37	170	Intestinal obstruction	..	+	.....	+	A	A $\frac{1}{4}$	o
34	M	48	184	Duodenal ulcer	..	..	Ulcer	+	B	C $\frac{1}{4}$	o
35	M	55	170	Duodenal ulcer	..	..	Ulcer	+	C	o	o
36	F	53	150	Intestinal obstruction (partial)	..	+	.....	+	B	o	o
37	F	40	140	Duodenal ulcer	..	..	Ulcer	+	A	A $\frac{1}{6}$	o
38	F	59	153	Renal calculus	..	+	.....	+	D	C $\frac{1}{2}$	o
39	F	29	155	Cholelithiasis	+	..	.....	+	B	B $\frac{3}{4}$	Negative shadows o
40	F	65	137	Psychosis cardiac	..	+	.....	+	C	C $\frac{1}{2}$	o

Notes
3 & 7

Note 5

Note 6

Note 4

TABLE 11 (Continued)

Case Number	Sex	Age	Weight	Final Clinical Diagnosis	Clinical Picture			Cholecystograms			
					Typical Gall-bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Intensity and Reduction in Size (after Fat Meal)	Calculi
41	F	59	137	Transcecal band	(?)	+	.....	+	B	B $\frac{1}{3}$	0
42	M	37	165	Tabes dorsalis	..	..	Ulcer	+	B	c $\frac{1}{3}$	0
43	F	44	145	Duodenal ulcer	..	+	Ulcer	+	c	c $\frac{1}{6}$	0
44	M	30	143	Duodenal ulcer	..	..	Ulcer	+	c	c $\frac{1}{4}$	0
45	F	32	124	Chronic appendicitis	..	..	Spastic Colon	+	B	B $\frac{1}{4}$	0
46	M	32	165	Anxiety neurosis	..	+	.....	+	B	c $\frac{1}{2}$	0
47	M	42	138	Spastic colon	..	+	.....	+	B	c $\frac{1}{3}$	0
48	M	27	172	Duodenal ulcer	..	+	.....	+	c	c $\frac{1}{4}$	0
49	M	45	160	Anxiety neurosis	..	+	.....	+	A	B $\frac{1}{2}$	0
50	F	34	124	Psychoneurosis	..	+	.....	+	c	c $\frac{1}{3}$	0
51	M	31	143	Psychoneurosis ? Chronic appendicitis	..	+	.....	+	c	c $\frac{1}{6}$	0
52	F	20	98	Pyloric ulcer	..	..	+	+	c	0	0
53	F	38	114	Psychoneurosis Arthritis	..	..	Mucous Colitis	+	B	B $\frac{1}{8}$	0
54	M	28	153	Duodenal ulcer	..	..	Ulcer	+	c	D	0
55	M	35	158	Labyrinthitis	..	+	.....	+	B+	B $\frac{1}{3}$	0
56	F	62	112	G. B. pathology Cardiac	+	..	.....	0	0	0	0
57	M	53	178	Duodenal ulcer	..	..	Ulcer	+	A	B $\frac{1}{4}$	0
58	F	45	147	Spastic colon	..	+	.....	+	A	A $\frac{1}{6}$	0
59	M	27	159	Spastic colon ? Duodenal ulcer	..	+	.....	+	B	B $\frac{1}{2}$	0
60	F	26	155	Urinary pathology	..	+	.....	+	A	B $\frac{1}{2}$	0
61	F	65	120	Cholelithiasis	..	+	.....	+	B	B $\frac{2}{3}$	Negative shadows
62	F	48	118	Duodenal ulcer	..	..	Ulcer	+	c	c $\frac{1}{6}$	0

Note 7

TABLE II (Continued)

Case Number	Sex	Age	Weight	Final Clinical Diagnosis	Clinical Picture			Cholecystograms				
					Typical Gall-bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Intensity and Reduction in Size (after Fat Meal)	Calculi	
63	M	40	157	Duodenal ulcer	..	..	Ulcer	+	C	C $\frac{1}{4}$	o	
64	F	40	110	Hypothyroidism	..	+	.....	+	D	D $\frac{1}{4}$	o	Note 5
65	F	58	141	Cardiac insufficiency	..	+	.....	+	C	C $\frac{1}{4}$	o	
66	M	58	127	Duodenal ulcer	..	+	.....	+	C	C $\frac{1}{4}$	o	
67	F	50	132	Chronic appendicitis	..	+	.....	+	B	B $\frac{1}{6}$	o	
68	M	53	124	Duodenal ulcer	..	..	Ulcer	+	B	o	o	
69	F	30	99	Psychoneurosis	..	+	.....	+	A	A $\frac{1}{4}$	o	Note 5
70	F	40	128	Spastic colon Psychoneurosis	..	+	.....	+	C	C $\frac{1}{4}$	o	
71	F	38	138	Cholelithiasis	+	..	.....	+	D	D $\frac{2}{3}$	Negative shadows	Note 3
72	F	37	140	Cholelithiasis	+	..	.....	+	C	D $\frac{1}{4}$	Negative shadows	Note 3
73	M	38	163	Chronic appendicitis	..	+	.....	+	B	B $\frac{1}{4}$	o	
74	M	51	141	Hodgkin's disease	..	+	.....	+	C	C $\frac{1}{2}$	o	
75	M	49	172	Duodenal ulcer	..	+	.....	+	B	B $\frac{1}{8}$	o	
76	M	37	135	Psychoneurosis	..	+	.....	+	B	B $\frac{1}{2}$	o	
77	M	55	220	Cardiac ? Coronary disease	..	+	.....	+	C	C $\frac{1}{3}$	o	
78	M	29	160	Duodenal ulcer	..	..	Ulcer	+	C	C $\frac{1}{4}$	o	
79	M	36	190	Duodenal ulcer	..	+	.....	+	C	D $\frac{1}{4}$	o	
80	F	24	121	Neurosis	..	+	.....	+	C	C $\frac{1}{4}$	o	
81	F	40	140	Myxedema	..	+	.....	+	B	B $\frac{1}{4}$	o	
82	F	40	136	Cholelithiasis	..	+	.....	+	C	o	Negative shadows	Note 3
83	F	29	125	Duodenal ulcer	..	+	.....	+	B	B $\frac{1}{6}$	o	
84	M	29	163	Duodenal ulcer	..	..	Ulcer	+	D	B $\frac{1}{4}$	o	Note 5

TABLE 11 (Continued)

Case Number	Sex	Age	Weight	Final Clinical Diagnosis	Clinical Picture			Cholecystograms				
					Typical Gall-bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Intensity and Reduction in Size (after Fat Meal)	Calculi	
85	M	32	135	Duodenitis	..	..	Ulcer	+	B	B $\frac{1}{6}$	o	
86	M	39	168	Duodenal ulcer	..	..	Ulcer	+	B	B $\frac{1}{6}$	o	
87	F	50	114	Chronic appendicitis	..	..	Ulcer	+	C	B $\frac{1}{4}$	o	
88	M	39	153	Duodenal ulcer	..	..	Ulcer	+	C	o	o	
89	F	21	.....	Migraine	..	..	Migraine	+	B	A $\frac{1}{3}$	o	
90	F	52	...	Duodenal ulcer	..	+	.....	+	B—	o	o	
91	F	28	142	Psychoneurosis	..	+	.....	+	B	B $\frac{1}{3}$	o	
92	F	38	120	Spastic colon ? Gall-bladder pathology	..	+	.....	+	D	D $\frac{2}{3}$	o	
93	M	47	168	Duodenal ulcer	..	..	Ulcer	+	A	A $\frac{1}{3}$	o	
94	M	48	200	Duodenal ulcer	..	+	.....	+	C	C $\frac{1}{8}$	o	
95	F	54	124	Hypothyroidism	..	+	.....	+	D	C $\frac{1}{3}$	o	
96	M	42	154	Spastic colon	..	+	.....	+	D	D $\frac{1}{3}$	o	
97	M	44	163	Spastic colon	..	+	.....	+	B+	C $\frac{1}{4}$	o	
98	F	52	124	Cholelithiasis Pyelitis	..	+	.....	+	C	C $\frac{1}{3}$	Positive shadows	Note 3
99	F	46	108	Labyrinthitis	..	+	.....	+	B	C $\frac{1}{6}$	o	
100	F	52	133	Tabes dorsalis	..	+	.....	+	B	B $\frac{1}{3}$	o	
101	M	47	192	Subacute appendicitis	..	..	Appendix	+	C	B $\frac{1}{4}$	o	
102	M	30	162	Duodenal ulcer	..	+	.....	+	C	o	o	
103	M	34	152	Psychoneurosis	..	+	.....	+	B	B $\frac{1}{3}$	o	
104	M	47	155	Spastic colon	..	+	.....	+	C	C $\frac{1}{3}$	o	
105	M	37	180	Duodenal ulcer	..	+	.....	+	C	C $\frac{1}{2}$	o	
106	M	29	158	Psychoneurosis	..	+	.....	+	C	C $\frac{2}{3}$	o	
107	F	49	136	Hypothyroidism	..	+	.....	+	B	B $\frac{1}{2}$	o	Note 5

TABLE II (Continued)

Case Number	Sex	Age	Weight	Final Clinical Diagnosis	Clinical Picture			Cholecystograms			
					Typical Gall-bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Intensity and Reduction in Size (after Fat Meal)	Calculi
108	F	41	126	Cholelithiasis	..	+	.....	+	B	B $\frac{1}{3}$	One large negative shadow
109	M	44	145	Duodenal ulcer	..	+	.....	+	B	B $\frac{1}{2}$	
110	M	34	136	Psychoneurosis	..	+	.....	+	C	D $\frac{1}{3}$	
111	M	42	180	Duodenal ulcer	..	+	.....	+	C	B $\frac{1}{3}$	
112	F	58	152	Duodenal ulcer	..	..	Ulcer	+	B	B $\frac{1}{3}$	
113	M	37	161	Psychoneurosis Hypothyroidism	..	+	.....	+	B	B $\frac{1}{4}$	
114	M	37	148	Duodenal ulcer	..	+	.....	+	A	A $\frac{1}{8}$	..... Note 4
115	F	38	140	.....	..	+	.....	+	B	B $\frac{1}{6}$	

1. Cholecystostomy nine years before, called normal gall-bladder.

2. No immediate reaction to intravenous dose; two hours after oral dose: nausea, vomiting and diarrhea.

3. Confirmed at operation.

4. Two previous oral examinations suggest pathology.

5. Phlebitis of injected vein.

6. Phlebitis and marked inflammation around injected vein.

7. Repeat by entirely intravenous test gave same results.

TABLE III
THE ORAL METHOD IN OUT-PATIENT HOSPITAL PRACTICE
Used routinely before the introduction of the combined method*

Case No.	Sex	Age	Weight	Clinical Picture			First Examination Filling	Repeat Examination Filling
				Typical Gall Bladder	Vague Indigestion	Suggesting other Digestive Syndromes		
1	F	24	211	+	..	.....	o	Not checked
2	F	48	181	.....	+	.....	+
3	F	67	134	.....	..	Back pain	o	Not checked
4	M	53	170	.....	..	Ulcer	o	No filling on combined
5	F	40	145	.....	+	.....	+
6	F	29	145	.....	+	.....	+
7	M	34	160	.....	..	Duodenal ulcer	+	
8	F	50	189	.....	+	.....	o	Not checked
9	M	47	136	.....	..	Urinary pathology	?	+
10	F	56	141	.....	..	Chest pathology	o	Not checked
11	F	54	158	.....	+	.....	+
12	F	60	159	.....	+	.....	+
13	M	43	160	.....	+	.....	+
14	F	67	188	.....	+	.....	o	o
15	F	24	128	.....	+	.....	+
16	F	63	156	.....	+	.....	+
17	F	30	110	R.U.Q. pain	..	.....	o	No filling on combined
18	M	39	134	.....	+	.....	+
19	F	53	162	+	..	.....	o	o
20	F	46	173	.....	..	L.U.Q. pain	o	Not checked
21	F	33	123	.....	+	.....	+
22	F	41	165	.....	+	.....	+
23	M	65	156	R.U.Q. pain	..	.....	o	o No filling on combined
24	F	50	153	.....	+	.....	o	Not checked
25	F	29	109	.....	+	.....	o ? Calculi	+

(* Note: When no shadow was obtained, checked by another oral test.)

TABLE III (Continued)

Case No.	Sex	Age	Weight	Clinical Picture			First Examination Filling	Repeat Examination Filling
				Typical Gall Bladder	Vague Indigestion	Suggesting other Digestive Syndromes		
26	F	37	153	.....	+	.....	o Negative shadows (?)	Not checked
27	M	24	162	.....	+	.....	?	Not checked
28	M	65	129	.....	+	.....	o	Not checked
29	M	57	181	.....	+	.....	o	Negative shadows on combined
30	F	44	128	R.U.Q. pain	..	.....	+
31	F	62	162	.....	+	.....	?	Not checked
32	F	52	138	.....	..	Carcinoma panc. & diabetes	?	Not checked
33	F	48	167	.....	+	.....	o	Not checked
34	F	43	125	R.U.Q. pain	..	.....	?	Not checked
35	M	53	183	.....	+	.....	+
36	F	38	166	+	..	.....	?	+
37	F	45	105	+	..	.....	+ Calculi	Not checked
38	F	37	162	.....	..	R.U.Q. pain 1 attack radiating down to pubis	+	
39	M	40	188	+	..	.....	Calculi o	Not checked
40	F	37	190	.....	+	.....	+
41	F	40	162	.....	+	.....	o	Not checked
42	F	36	145	.....	..	R.U.Q. pain	o	+
43	M	34	114	.....	..	R.U.Q. pain	+	
44	M	58	150	.....	+	.....	+
45	M	55	158	.....	..	R.U.Q. pain	o	+
46	F	40	138	.....	+	.....	+
47	M	37	172	.....	+	.....	o	+
48	M	19	138	.....	..	R.U.Q. pain	+	
49	F	22	127	.....	..	Jaundice & R.U.Q. pain	+	
50	F	40	110	.....	+	.....	+

TABLE IV
COMBINED METHOD IN HOSPITAL OUT-PATIENT PRACTICE

Case No.	Sex	Age	Weight	Clinical Picture			Cholecystograms				Remarks
				Typical Gall Bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Density and Reduction in Size (after Fat Meal)	Cal-culi	
1	F	39	130	.....	+	.....	+	A—	A— $\frac{1}{2}$	0	
2	F	40	159	.....	+	.....	+	C+	C— $\frac{2}{3}$	+	
3	F	49	170	.....	+	.....	+	C+	C— $\frac{2}{3}$	+	
4	F	41	145	+	..	.....	+	D	D same	0	
5	F	40	157	.....	..	Attacks of epigastric pain	+	A+	A $\frac{1}{2}$	0	
6	F	40	151	R.U.Q pain	..	.....	+	C	0	0	Previous oral method showed no gall-bladder shadow
7	M	28	132	.....	..	Ulcer Hepatitis	+	A—	B+	0	
8	F	54	153	.....	+	.....	+	A—	A— $\frac{1}{2}$	0	
9	F	43	178	.....	+	.....	+	A+	D $\frac{1}{4}$	0	
10	F	48	138	.....	+	.....	+	C—	C+ $\frac{1}{4}$	0	
11	F	40	182	+ Jaundice	..	.....	0				
12	M	36	190	?	..	.....	+	B	C— $\frac{1}{6}$	+	
13	F	49	137	.....	+	.....	+	B—	B+ $\frac{1}{4}$	0	
14	M	50	130	.....	+	.....	+	D—	D— $\frac{1}{2}$	0	
15	F	39	136	.....	+	.....	0				
16	M	39	175	.....	..	Upper abdominal pain	+	D	0	0	
17	F	60	168	+	..	.....	+	B	B $\frac{1}{2}$	0	
18	F	52	177	+	..	.....	0				
19	F	66	177	.....	+	.....	+	C—	C same	0	
20	F	65	127	.....	..	Colitis	+	C—	B— $\frac{1}{3}$	0	
21	F	49	...	.....	+	.....	+	A	A+ $\frac{1}{3}$	0	

TABLE IV (Continued)

Case No.	Sex	Age	Weight	Clinical Picture			Cholecystograms				Remarks
				Typical Gall Bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Density and Reduction in Size (after Fat Meal)	Calculi	
22	F	40	145	.....	+	.....	+	B—	C+ $\frac{1}{6}$	0	
23	F	48	.....	.....	+	.....	+	A	A+ $\frac{1}{6}$	0	
24	M	41	145	.....	+	.....	+	B	0	0	
25	F	25	125	+	..	.....	+	C	C $\frac{3}{4}$	0	
26	F	40	160	.....	..	Colitis	+	B	B+ $\frac{2}{3}$	+	
27	M	44	141 $\frac{1}{2}$	.....	+	.....	+	B	B— $\frac{1}{4}$	0	
28	F	47	165	.....	+	.....	+	A	A— $\frac{1}{4}$	0	
29	F	47	156	+	..	.....	0	...	.....	+
30	F	34	130	?	..	.....	+	A	A $\frac{1}{2}$	0	
31	M	25	125	.....	+	.....	+	A—	A $\frac{1}{5}$	0	
32	F	45	145	.....	+	.....	+	C	C+ $\frac{2}{3}$	0	
33	F	50	189	.....	+	.....	0	...	.....	0	No filling on two attempts by combined method
							0			0	
34	F	40	164	.....	..	History of jaundice Clay-colored stools	+	A	A $\frac{1}{4}$	0	
35	F	56	165	.....	+	.....	0	...	.....	0	No filling on two attempts by combined method
							0			0	
36	M	63	109	.....	..	Carcinoma of pancreas	0	...	.....	0	No filling on two attempts by combined method
							0			0	
37	F	54	.....	.....	+	.....	+	A—	A+ $\frac{1}{4}$	0	
38	M	54	107	.....	+	.....	+	C—	C+ $\frac{2}{3}$	0	
39	F	33	91 $\frac{1}{2}$	.....	+	.....	+	C—	B $\frac{1}{6}$	0	
40	F	41	174	+	..	.....	0	...	.....	0	

TABLE IV (Continued)

Case No.	Sex	Age	Weight	Clinical Picture			Cholecystograms				Remarks
				Typical Gall Bladder	Vague Indigestion	Suggesting Other Digestive Syndromes	Filling	Density (before Fat Meal)	Density and Reduction in Size (after Fat Meal)	Calculi	
41	F	66	142	.....	+	.....	+	A+	A+½	0	
42	M	41	163	.....	+	.....	+	B—	B—⅓	0	
43	F	36	156	+	..	.....	+	C	C ½	0	
44	F	38	148	.....	+	.....	+	A	A ¼	0	
45	F	40	118	.....	+	.....	+	A	A ⅔	0	
46	F	38	138	.....	+	.....	+	B	B ⅓	0	
47	F	55	145	.....	+	.....	+	C—	C+½	0	
48	F	42	128	.....	+	.....	+	A+	A+½	+	
49	F	40	134	.....	+	.....	+	A	C ⅔	0	
50	..	..	...	.....	..	.....	+	B+	A ½	0	

SUMMARY OF RESULTS

ORAL METHOD IN OFFICE PRACTICE

Summary of 100 cases examined by oral method and repeat by intravenous method where necessary.

(Symptoms not those of definite gall-bladder disease)

First Examination

Satisfactory filling.....	79
No filling.....	20
Questionable filling.....	1
Questionable calculi (without gall-bladder outline).....	1

*Second Examination**Of those with no filling on first examination**By intravenous*

Satisfactory filling.....	16
No filling.....	1
Satisfactory filling suggesting pathology.....	3
Not checked.....	4

Of one with questionable filling

Satisfactory filling.....	1
---------------------------	---

Of one with questionable calculi

Satisfactory filling without evidences of calculi..... 1

Density

A	3	4 per cent of the	79 filled cases
B	16	20 per cent of the	79 filled cases
C	32	41 per cent of the	79 filled cases
D	28	35 per cent of the	79 filled cases
O	21	21 per cent of the	100 total cases

COMBINED METHOD IN OFFICE PRACTICE

Summary of 115 unselected digestive cases examined by combined method, and checked by intravenous where necessary.

<i>Satisfactory Filling</i>	110
<i>No Filling</i>	5

Corroborating clinical story of gall-bladder pathology..... 4

Proved by operation..... 2

Checked by intravenous (same results). 2

Previous cholecystostomy..... 1

Calculi..... 9

Proved at operation..... 5

No operation..... 4

Negative shadows		Of those not filling on first examination (8)	
With gall-bladder outline.....	7	Negative shadows in region.....	2
Without gall-bladder outline.....	0	Typical gall-bladder history.....	2
Positive shadows		Obstruction due to carcinoma of pancreas	1
With gall-bladder outline.....	1	Vague indigestion.....	1
Without gall-bladder outline.....	1	Repeated with combined method (same results).....	2
Density (before meal)		Density	
A 15 14 per cent of the 110 filled cases		A 17 40 per cent of 42 filled cases	
B 51 46 per cent of the 110 filled cases		B 10 24 per cent of 42 filled cases	
C 37 34 per cent of the 110 filled cases		C 12 29 per cent of 42 filled cases	
D 7 6 per cent of the 110 filled cases		D 3 7 per cent of 42 filled cases	
O 5 4 per cent of the 115 total cases		O 8 16 per cent of 50 total cases	

ORAL METHOD IN OUT-PATIENT HOSPITAL PRACTICE

Summary of 50 consecutive cases examined by oral method and repeat by oral and combined methods where necessary.

First Examination

Satisfactory filling.....	23
No filling.....	21
Questionable filling.....	6
Questionable calculi (without filling)...	2

Second Examination

Of those with no filling on first examination

Satisfactory filling.....	4
No filling	
(Oral).....	2
(Combined).....	2
Negative shadows.....	1
Not checked.....	11

Of those with questionable filling

Satisfactory filling.....	3
No filling.....	0
Not checked.....	4

Of those with questionable negative shadows but no gall-bladder outline

Satisfactory filling.....	1
Not checked.....	1

COMBINED METHOD IN HOSPITAL OUT-PATIENT PRACTICE

Summary of 50 consecutive cases examined by the combined method, and in certain cases repeated.

Satisfactory filling.....	42
No filling.....	8
Questionable filling.....	0
Calculi	
With gall-bladder outline.....	5
Without gall-bladder outline.....	1
Questionable calculi	
With gall-bladder outline.....	2

DISCUSSION

At this point, we do not wish to enter into controversial matters in diagnosis of gall-bladder pathology. There can be no doubt that those of us whose practice is largely medical, miss, because of over-conservatism, a certain number of pathological gall bladders. For example, it has been our policy to consider a normally filling and emptying gall bladder without calculi as definitely not the seat of disease; yet, we have had several such patients operated upon, when the clinical history was sufficiently definite, and have obtained complete relief from symptoms. On the other hand, we feel that pathology can be diagnosed more definitely by a well-done cholecystogram than at the operating table; here function, as determined by x-ray, is often more valuable than direct inspection.

The oral method is overwhelmingly the most popular, although our results demonstrate its indefiniteness, particularly in hospital outpatient practice. X-rays of the gall bladder require, in addition to sufficient opaque substance in the organ, considerable technical skill and care. In a hospital outpatient department, the pressure of work does not allow the necessary individual development of films, often so valuable in procuring satisfactory gall-bladder visualization, particularly with the less dense oral shadows. The patient's personal factors in the hospital outpatient department, such as linguistic and educa-

tional difficulties, make the oral procedure difficult. But even in the better-controlled office practice, where instructions are accurately observed, films developed individually, many techniques of exposure tried, and such helps as enemata resorted to, the oral method is indefinite. The combined method has shown an accuracy comparable to the intravenous by operative findings, intravenous checks, and correlation with the clinical facts.

Indiscriminate intravenous medication of any type has, with reason, been looked upon with disfavor. Contraindications such as infection, marked allergy, cardiac failure and coronary thrombosis should be heeded even with the smaller doses of the combined method, but it has been our experience that the marked digestive upsets occurring frequently with the oral method may present more of a risk than the intravenous injection, carefully and slowly performed.

Levene and Whitaker¹ have used a combined method with two-thirds of the oral and two-thirds of the intravenous doses, and have reported that their patients have been "singularly free from any of the reactions which may follow a full intravenous or a full oral dose." In our experience using only one half of each dose there have been several instances of phlebitis of the injected vein, and in one case a severely sore arm for two weeks. Except for one case which is very doubtful, we

¹Levene, G. and Whitaker, L. R. New methods for the clinical study of the gall bladder. *New England J. M.*, 202: 203-14, 1930.

have had no general reactions following the intravenous injection, but digestive disturbances have occurred about two hours after the oral dose, comparable, though less in intensity, to those often obtained with the oral method alone.

The certainty of results, elimination of the necessity of hospitalization, and infrequency of reactions make the combined method suitable for the study of ambulatory cases. We do not, however, feel that the intravenous method can be improved upon for hospital in-patients.

CONCLUSIONS

1. Cholecystography by the combined oral and intravenous method presents an accuracy comparable to that of the intravenous method.
2. It produces a higher incidence of filling and denser shadows than the oral method.
3. Reactions are infrequent; those present are apparently due to the dose taken by mouth.
4. It is time saving, requiring but little more than the oral method, yet requiring no repeat examinations.
5. Cholecystography by the combined oral and intravenous method is the most satisfactory means of studying ambulatory cases.

The kindly cooperation of Dr. J. H. Pratt, Physician-in-chief, and Dr. H. F. Friedman, Roentgenologist to the Boston Dispensary, is acknowledged.



CLINICAL REPORT ON A URINARY ANTISEPTIC*

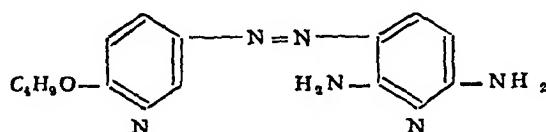
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EACH of us is daily confronted with the problem of urinary antisepsis. This statement applies particularly to those of us doing urological work exclusively but includes also each and every one engaged in general practice. Cases of urinary infection, characterized chiefly by frequent and painful urination and by the presence of pus or bacteria, or both, in the freshly voided urine, are observed very frequently, in either sex, at any age. Those instances of urinary infection not frankly traumatic in origin, or due to faulty instrumentation, we are all accustomed to explain on a hematogenous basis by reason of an associated extra-urinary focal infection or an acute infectious disease. We have been able to establish a fairly definite relationship between urinary infections and certain predisposing or accessory causes, chief among which are imperfect urinary drainage, stone, tumor, foreign body and trauma. Our knowledge, however, as to the exact etiology and mechanism of urinary infections remains rather meager. And when we come to a consideration of the treatment of these infections, we encounter a problem even more baffling. Up to the present time there has been no known drug which might be given by mouth and which could be depended upon to prevent the growth and development of bacteria within the urinary tract.

In the early experimental work upon this subject by Davis, the ideal internal urinary antiseptic was defined as a chemically stable compound, comparatively non-toxic, and non-irritating to the lower urinary tract, which is eliminated, unchanged by the kidney, and which exerts a definite antiseptic action in high dilution in urine of any reaction.

Many drugs have been tried and found wanting, but during the past year we have had brought to our attention a substance appearing under the name of "niazo" which is briefly a diazotized pyridin product designed for oral administration as a urinary antiseptic. Chemical and pharmacologic nature show it to be a bright yellow micro-crystalline powder with the structural formula:



Niazo is well tolerated by more highly developed animals. Protracted administration in animal experiments showed that a dog will tolerate a dose of 120 mg. per kilo daily, over a period of thirty days without showing symptoms of kidney irritation. The administration of a single dose of 0.5 gm. per kilo was tolerated without any reaction. Only larger doses produced secondary effects such as diarrhea and vomiting.

Niazo is quickly absorbed, it is eliminated chiefly through the kidneys, partly through the liver. After the administration of the drug the urine shows a reddish-yellow color. It is necessary to keep this in mind, because it avoids mistaking it for biliary pigment or blood in the urine.

A sufficient adult dosage is 2-3 tablets after each meal but larger doses than this have been given in our series without toxic symptoms. It has also been found that the best results are obtained when the patient limits his fluid intake to about 1500 c.c. in the twenty-four hours. Most patients report after twenty-four hours a lessening in bladder spasm and note a soothing effect

* Submitted for publication November 13, 1931.

TABLE I
CASES TREATED WITH NIAZO

Case	Sex	Age	Organism	Diagnosis	Treatment Before Drug was Given	Duration of Disease	Length of Medication	Number of Tablets Daily	Results
3205	M	38	B. coli, Cocci	Pyelonephritis	Dil. ureteral stricture	1 yr.	8 wks.	8	Good
2148	M	53	B. coli	Acute cystitis	Prostatectomy	3 yrs.	3 wks.	6	Good
3108	M	61	B. coli, Cocci	Cystitis, Bl. tumor	Fulguration of growth	14 mo.	4 wks.	6	Excellent
*3261	F	62	Mixed	Rt renal calculus	Nephrolithotomy	2 yrs.	3 wks.	3	Fair
2968	F	29	B. coli	Cystitis, Pyelitis	None	3 wks.	17 da.	5	Fair
3190	M	35	Gonococci	Acute p. urethritis	Hot Sitz baths	6 da.	10 da.	6	Good
3302	M	18	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	15 da.	6	Good
3332	M	27	Gonococci	Acute p. urethritis	Hot Sitz baths	4 da.	18 da.	6	Good
3207	M	44	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	14 da.	6	Fair
2080	M	29	Gonococci	Prostatic abscess	Incision—drainage	16 da.	21 da.	6	Good
3301	M	20	Gonococci	Acute urethritis	Urethral irrigations	1 da.	14 da.	6	Excellent
*3330	M	26	Gonococci	Acute p. urethritis	Urethral irrigations	14 da.	7 da.	3	Good
3348	M	58	B. coli, Cocci	Acute cystitis	Removal pros. obstruc.	6 yrs.	20 da.	6	Excellent
3230	M	64	B. coli, Cocci	Chronic cystitis	Removal bl. calculus	15 mo.	21 da.	6	Good
3372	M	28	Gonococci	Acute p. urethritis	Hot Sitz baths	10 da.	7 da.	8	Excellent
2031	M	56	B. coli	Cystitis	None	3 wks.	14 da.	6	Excellent
3378	M	19	Gonococci	Acute p. urethritis	Hot Sitz baths	2 da.	10 da.	6	Good
3362	F	61	Mixed	Cystitis, Bl. tumor	Bladder resection	1 yr.	19 da.	6	Good
3433	F	37	B. coli	Acute cystitis	None	2 wks.	14 da.	6	Excellent
3535	F	27	Cocci	Cystitis, Pyelitis	None	12 da.	17 da.	6	Excellent
2825	M	66	Mixed	Pyelonephritis	Ureterolithotomy	3 wks.	23 da.	6	Good
3503	M	64	B. coli	Chronic cystitis	Prostatectomy	8 yrs.	18 da.	6	Excellent
3530	M	29	Gonococci	Acute p. urethritis	Hot Sitz baths	4 da.	10 da.	6	Good
3556	M	27	Gonococci	Acute p. urethritis	Hot Sitz baths	6 da.	15 da.	6	Good
3541	F	57	B. coli, Cocci	Acute cystitis	None	3 wks.	10 da.	6	Excellent
3554	M	21	Gonococci	Acute p. urethritis	Hot Sitz baths	4 da.	14 da.	6	Good
2427	M	26	Gonococci	Acute p. urethritis	Hot Sitz baths	2 da.	20 da.	6	Good
3514	M	34	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	15 da.	6	Excellent
3547	M	34	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	20 da.	6	Good
3542	M	30	Gonococci	Acute p. urethritis	Hot Sitz baths	2 da.	16 da.	6	Good
2904	F	72	Mixed	Cystitis, Bl. tumor	Fulguration	5 mo.	14 da.	6	Excellent
3480	F	33	Gonococci	Acute urethritis	None	7 da.	20 da.	6	Good
3490	M	34	Mixed	Acute cystitis	Dil. urethral stricture	3 wks.	12 da.	6	Good
3528	M	33	B. coli, G. C.	Prostatic abscess	Incision—drainage	2 wks.	21 da.	6	Good
3550	M	64	B. coli	Cystitis	Prostatectomy	2 yrs.	14 da.	8	Good
3496	M	26	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	16 da.	6	Good
2531	M	75	Mixed	Cord bladder	None	2 yrs.	5 wks.	6	Unimproved
2670	F	52	Gonococci	Acute urethritis	None	7 da.	21 da.	6	Excellent
3412	M	30	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	14 da.	6	Good
2118	F	35	B. coli, Cocci	Acute cystitis	None	3 wks.	20 da.	6	Excellent
2050	M	45	B. coli, Cocci	Prostatitis	Hot Sitz baths	9 da.	16 da.	8	Good
3401	F	44	Mixed	Bl. diverticulum	Diverticulectomy	3 yrs.	30 da.	6	Good
3236	M	35	Gonococci	Urethritis	Irrigations	2 da.	15 da.	6	Excellent
3416	M	35	Gonococci	Acute p. urethritis	Hot Sitz baths	5 da.	14 da.	6	Good
2877	M	30	B. coli, Cocci	Prostatitis	Prostatic massage	2 mo.	18 da.	6	Good
2060	M	61	Mixed	Prostatic adenoma	None	3 yrs.	30 da.	6	Unimproved
3486	F	56	B. coli	Cystitis	Irrigations	2 wks.	18 da.	6	Excellent
3475	M	30	Gonococci	Acute p. urethritis	Hot Sitz baths	7 da.	20 da.	6	Good
3408	M	43	B. coli, Cocci	Prostatitis	Massage	1 mo.	14 da.	6	Good
3522	M	23	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	.....	6	Unable to follow
3516	F	22	B. coli, Cocci	Cystitis, Pyelitis	None	4 wks.	28 da.	6	Excellent
3478	M	39	Mixed	Cystitis	None	2 wks.	21 da.	6	Excellent
3510	F	43	B. coli, Cocci	Acute cystitis	Dil. urethral stricture	1 yr.	15 da.	6	Excellent
3485	M	33	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	12 da.	6	Good
3487	F	38	Gonococci	Acute urethritis	None	1 wk.	14 da.	6	Excellent
3477	F	23	B. coli, Cocci	Cystitis, Pyelitis	None	2 wks.	16 da.	6	Good
3410	M	63	Mixed	Cystitis, Bl. tumor	Fulguration	1 yr.	21 da.	6	Excellent
3259	M	42	B. coli, Cocci	Bl. calculus	Removal of calculus	8 mo.	14 da.	8	Good
3529	M	85	Mixed	Chronic cystitis	Prostatectomy	5 yrs.	30 da.	5	Good
3424	M	25	Gonococci	Urethritis	Irrigations	4 da.	16 da.	6	Excellent
3000	M	73	Mixed	Chronic cystitis	None	2 yrs.	25 da.	6	Unimproved
3508	F	40	B. coli, Cocci	Pyelonephritis	Catheter drainage	3 wks.	20 da.	6	Excellent
3519	M	32	Gonococci	Acute p. urethritis	Hot Sitz baths	5 da.	15 da.	6	Good
3443	M	25	B. coli, G. C.	Prostatic abscess	Incision—drainage	3 wks.	21 da.	6	Fair
3474	M	27	B. coli	Pyelitis	None	2 wks.	25 da.	6	Fair
3337	F	22	Cocci	Pyelonephritis	None	4 wks.	33 da.	6	Good
3513	F	63	B. coli	Renal calculus	Nephrolithotomy	1 yr.	25 da.	5	Good
3492	M	27	Gonococci	Acute p. urethritis	Hot Sitz baths	3 da.	16 da.	6	Good
3432	M	32	Gonococci	Acute p. urethritis	Hot Sitz baths	5 da.	20 da.	6	Good
3521	F	46	Mixed	Renal calculus	Nephrolithotomy	3 yr.	20 da.	6	Fair

* Cases which showed some gastric distress.

or decrease in urethral burning. Freeing urine of pus and bacteria varied greatly. We have found niazo of greatest advantage in the acute fulminating, posterior gonorrheal infections. Large doses over a period of several days with hot Sitz baths give the patients more benefit than anything we have tried so far.

In all cases studied except those with acute urethral symptoms, a complete physical and urological examination was made to rule out or correct all urinary tract abnormalities.

Table 1 shows what was accomplished in 70 cases in which niazo was administered orally. In this chart practically every type of urinary infection is represented that the practitioner meets with in daily practice.

Judging from the table there was improvement, considered satisfactory in about 87 per cent of patients receiving the drug. The prompt effect of niazo on bacteria, especially cocci, was surprising. It was in gonococcal infections that niazo seems to have a real selective action.

In conclusion, I would only reiterate the fact that it appears, from present indications, that the introduction of the chemotherapeutic dye preparations heralds a new epoch in urinary antiseptics. The work done so far on drugs of this type has been most auspicious. It behooves clinicians to familiarize themselves with these newer agents and to apply them rigorously in order that a logical therapy in combating urinary infections may be established.

In this field of endeavor, there is cause for optimism rather than pessimism, for the reason that the one greatest obstacle has been surpassed. It has been conclusively demonstrated that there are several chemical compounds, one of these being the newer agent, niazo, which may pass through the gastrointestinal tract, the blood stream and the kidneys of normal human individuals, rendering the urine an unfit culture medium for microorganism, and in no way injuring the body. It has further been shown that in selected cases these drugs exert a curative effect upon inflammatory conditions in the urinary tract.

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TIDAL IRRIGATION & SUCTION APPARATUS FOR EMPYEMA*

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WE were impressed two years ago by Hart's¹ publication describing an apparatus for the treatment of empyema by tidal irrigation and suction. It seemed that the principles which he suggested were correct. I have modified Hart's apparatus in several particulars which, I believe, make the apparatus simpler in design and easier to assemble and operate. The patient can be easily transported to the roentgenological laboratory without detaching the apparatus.

A graduated flask containing the irrigating fluid is connected by means of a Y tube with the drainage tube that goes to the chest. A Hoffman clamp is placed between the irrigating solution and the drip connection in order to control the flow. The constant addition of fresh solution to the system needs only to be 20 to 30 drops per minute. Physiologic saline solution seems to be the most satisfactory solution for irrigation.

The outlet tube is used for siphonage as in all cases of closed drainage, but the amount of suction is controlled by the interposition of two bottles in the siphonage system. The first of these bottles is kept on a level with the chest of the patient and acts as a reservoir for fluid which goes in and out of the chest during inspiration and expiration. The second bottle is a water trap to control the amount of suction applied. It can be raised or lowered in order to secure any desired siphonage or suction. A water manometer

¹Hart, D., Method of treatment (of empyema) by tidal irrigation and suction with results in 30 cases. *Internat. S. Digest*, 7: 3-11, 1929.

Hart, D., Acute empyema. *Arch. Surg.*, 17: 102, 116, 1928.

is connected to the tidal wash bottle so that the amount of suction can be determined. The water trap is then adjusted so that the suction applied is only slightly more than that which normally exists within the empyema cavity. Maximal interchange of fluid between the chest cavity and the tidal wash bottle will be obtained when the suction that is applied does not exceed the mean pressure that exists normally in the pleural cavity. The manometer fluctuates with the changes in pressure in the system and thereby aids materially in adjusting the water trap to secure the proper amount of suction.

A waste bottle collects the overflow from the water trap or second bottle. The entire apparatus has been mounted on upright rods with adjustable clamps so that it can be fastened to any hospital bed. The patient can be moved in bed without disturbing the action of the apparatus (see Fig. 2).

The advantages of maintaining a sub-atmospheric pressure in the pleural cavity during the period of time that surgical drainage of the purulent material is required needs no further comment. The principal objections to the closed system of drainage have been (1) an inability to keep the drainage tube from becoming blocked with exudate, fibrin or pus, (2) the possibility of the formation of secondary collections because of too rapid expansion of the lung, (in acute cases, if the drainage tube is carried from the chest of the patient to a bottle on the floor the amount of siphonage is excessive and the lung is too rapidly sucked down to the position of the tube in the chest leaving purulent material in some parts of the

*This apparatus was developed at the University of Pennsylvania, Surgical Service B.
Submitted for publication May 20, 1931.

empyema cavity undrained), (3) leakage about the tube in the chest, especially when irrigated under positive pressure, (4) to occur, (3) gradual, minimal suction re-expands the lung slowly and continuously, (4) the apparatus can be attached

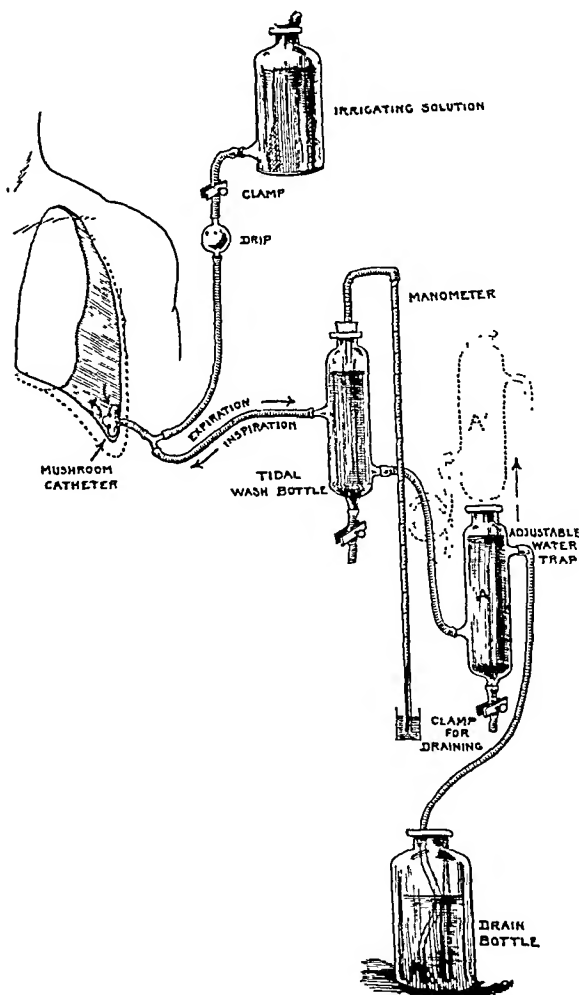


FIG. 1. Arrangement of bottles in empyema apparatus. Tidal wash bottle is level with chest of patient. Water trap is adjustable and controls amount of suction applied. Manometer is an open one so that it not only indicates variations in negative pressure created in system, but prevents excessive positive pressure in system when patient coughs as air will bubble out through manometer. All of the bottles are made of heavy pyrex glassware.

technical difficulties in care of the drainage apparatus and the nursing care of the patient.

In the apparatus here described, use is made of the following factors: (1) a non-irritating fluid is slowly and continuously added to the system, (2) there is a continual washing or tidal flow of this fluid in and out of the chest with each respiratory act so that blockage of the tube is less apt

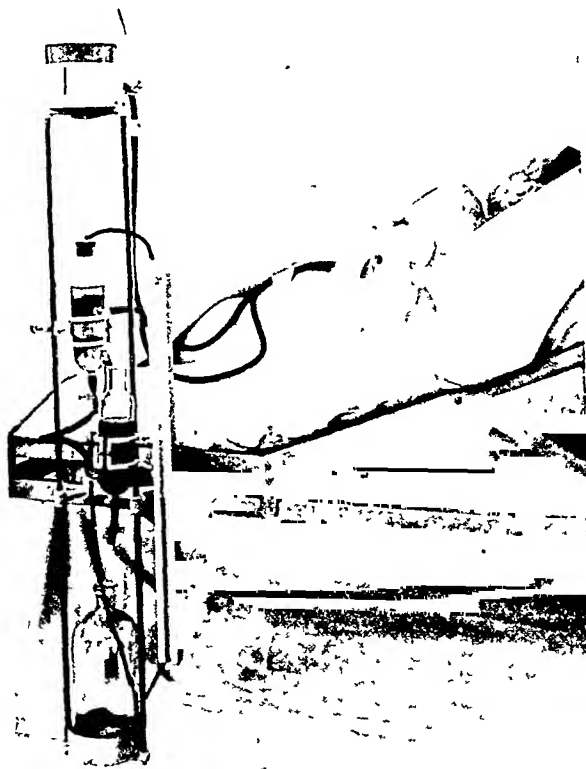


FIG. 2. Empyema apparatus showing connections to chest of patient and adjustable bed support.

completely to the bed so that the care of the patient is not complicated. The only nursing requirement in connection with the apparatus consists in filling the irrigating flask with solution every six to eight hours. Dressings of the thoracotomy wound rarely have to be changed more than once or twice weekly. (5) Leakage about the tube in the chest is minimized since constant suction is applied and blockage of the tube rarely occurs. In adults a mushroom catheter is inserted through a large cannula and withdrawn so that the flange of the catheter fits snugly to the parietal pleural opening within the empyema cavity. This eliminates the possibility of too long a tube within the empyema cavity. The mushroom catheter can be inserted through a cannula without difficulty by passing a grooved director through

its lumen until the rubber flange has been stretched out, thereby diminishing its diameter. In children a large Nélaton

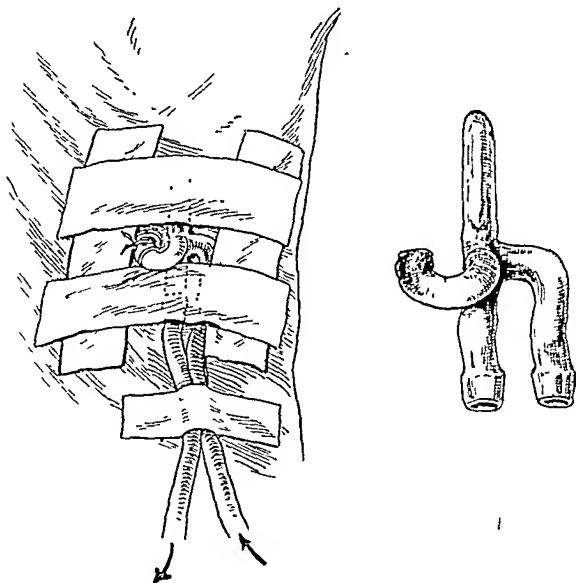


FIG. 3. Glass tube used to connect inlet and outlet tube with thoracotomy drain. Such a connection prevents kinking of thoracotomy tube and facilitates anchorage of tube to chest wall.

catheter inserted through a small opening in a piece of rubber tissue makes a satisfactory air-tight thoracotomy tube.

A curved glass connecting tube has been devised which prevents twisting or kinking of the drain at its point of exit from the chest (see Fig. 3). The drainage tube which enters the chest is cut short, 1.5 to 2 cm. from the chest wall and slipped over the curved end of the connecting tube. The rubber tube is secured in place by wrapping the tube at the point of overlap with silk thread. Separate openings provide for connection with the inlet and outlet tube. The addition of fresh solution to the system at a point near the empyema cavity is an important aid in the preven-

tion of blockage of the thoracotomy tube. The entire connecting piece can be secured to the chest wall with adhesive tape. With such an arrangement it is possible for the patient to lie directly back on the drainage tubes or to move about in bed without the danger of kinking the tubes.

In the event of a bronchial fistula, the siphonage described here would, of course, fail to be maintained as air would gain entrance through the fistula. When a bronchial fistula exists, the water manometer is disconnected and additional suction applied through the rubber tube connected to the top of the tidal wash bottle. This additional suction can be supplied from a water suction pump connected to a nearby water faucet or by means of an electric suction apparatus. The adjustable water trap (A in Fig. 1) will continue to regulate the amount of suction. When the air that enters the system by way of the fistula does not exceed that leaving by the additional suction applied to the tidal wash bottle, air will be drawn up through the water trap and that amount of pressure controlled by the difference in the heights of the two bottles will be maintained. By sucking air out of the empyema cavity faster than it can enter by way of the fistula there will be a tendency for the cavity to decrease in size. When the fistulous opening on the lung surface reaches the parietal wall of the cavity, the fistula will close and additional suction will be unnecessary. Should continued suction fail to re-expand the lung, as may occur in chronic cases, one or another of the surgical procedures now used for obliteration of the cavity can be adopted.



AN UNUSUAL CASE OF TUBERCULOSIS OF THE TROCHANTERIC REGION

BONE INFECTION NEAR THE JOINT*

EMIL D. W. HAUSER, M.D., F.A.C.S.

CHICAGO

BONE infections near a joint offer several problems to the orthopedist. First, it is difficult to establish an

tuberculous. Later the hip became involved with a destructive arthritis typical of tuberculosis.



FIG. 1. X-ray of hip when first seen, one year after onset of symptoms.



FIG. 2. X-ray of hip three months after operation.

early diagnosis. Later, when the x-ray shows the lesion, the etiology often remains obscure. The treatment, furthermore, demands judgment. It is hard to decide whether or not to operate. The optimum time for surgical interference varies with the individual case. All of these points are clearly illustrated by the case I wish to discuss. For nearly three years previous to the time that the patient was first seen, she had been treated by several physicians for tuberculosis of the hip. The roentgenogram, however, showed a lesion in the upper part of the femur, with the hip joint apparently free. At operation the lesion proved to be

The patient, a girl five years of age, had fallen on a step and three days later had begun to limp. Soon after she began to complain of pain in the left hip; the pain would sometimes occur at night and awaken her. She was treated in turn by the local physician, an osteopath and a chiropractor, but continued to grow worse. After three months had elapsed the child was taken to a neighboring city to an orthopedist who applied a plaster-of-Paris cast to fix the hip. The parents were told that the child had a tuberculous hip. She wore a cast for four months and used crutches for three months longer. She had relief from her pain at once. When the cast was removed she walked without a limp and had no pain. She stayed well for nearly three months when the

* Submitted for publication May 18, 1931.

symptoms recurred, more severe than before. A year later the family physician noticed a swelling on the outer side of the thigh. He

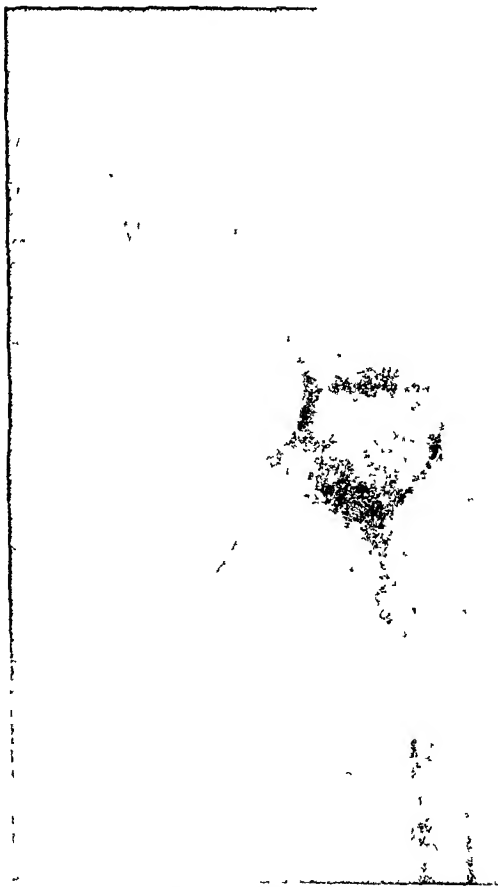


FIG. 3. X-ray of hip nine months later.

incised this area and encountered pus. The wound drained for six weeks, during which time the patient was in bed with severe pain. A spica cast was again applied. The symptoms, however, persisted and the child gradually lost weight and strength. After three months she was brought for further consultation.

Examination showed a thin, pale child with a short loose-fitting cast on the left hip. The cast was removed and, in view of the history, the motion at the hip seemed unusually good. The roentgenogram showed an abscess in the upper end of the femur. In consideration of the history of the case it was thought best to treat conservatively for a while. There was a flexion and adduction deformity of the hip. Under general anesthesia the hip was easily brought to the mid-position; a plaster-of-Paris cast was applied from the axilla to the ankle, with immediate relief of pain. General

hygienic measures, rest, fresh air, a high caloric diet, tonics, cod-liver oil and sunshine were prescribed.

The child gained in weight and seemed well in every way. The casts were changed and radiograms were made of the hip periodically. About six months after the application of the first cast the x-ray plate revealed a small dense area in the upper end of the femur. Three months later an area of absorption was visible around the area previously noted, and six weeks later the area of absorption was seen to be definitely increased. At the same time there was some swelling and tenderness present over the outer side of the left thigh below the greater trochanter. A provisional diagnosis of abscess in the upper end of the femur, *probably tuberculous*, was made and an exploratory operation advised.

A lateral incision exposed a cavity in the upper end of the femur which was filled with pus and contained two sequestra. The cavity when cleansed was found to be about the size of a hen's egg which, when we consider the age of the child, was relatively large. Anteriorly an opening the size of a dime connected with a well walled-off pocket of pus in the adductor group of muscles. The pus was removed and the cavity washed with iodine and alcohol; the wall of the bony cavity was made smooth with a curette and then wiped with iodine and alcohol. The cavity was made as shallow as possible by removing part of the wall; the remaining cavity was then lined with a thin layer of Bipp paste (iodoform, bismuth and paraffin). A fat graft was then swung down from above and another brought up from below to fill the cavity. The wound was closed and a plaster of Paris cast applied from the axilla to the toes.

A smear made of the pus taken from the femur showed staphylococci. The Ziehl-Nielsen stain showed several rod-like, acid fast bacilli. A blood agar plate was cultured and a guinea-pig injected. The culture showed grayish hemolytic colonies made up of gram positive cocci arranged in clusters. Two hours after the injection the guinea-pig died of peritonitis, and *Staphylococcus aureus*, identical with the original specimen, was demonstrated. Attached to the fragments of bone which had been removed was some grayish tissue resembling granular tissue; in this were found round or oval structures like tubercles, which contained

many epithelial cells and multinucleated giant cells; some granular tissue of the type which borders a tuberculous abscess, was also present. In specially stained section, inclosed within the giant cells, two rod-shaped, acid-fast bacilli were found. A guinea-pig inoculated with a salt suspension of pus from the femur was killed six weeks later. Many tuberculous changes were recognized in the lymph nodes, spleen and liver. Direct smears made of a lymph node showed many tubercle bacilli.

The rapidity with which the first guinea-pig died caused some concern as to the effect of so virulent an infection upon the patient. Confidence in the child's resistance was justified, however, and she remained comfortable. At no time did the temperature rise above 99.6°F. The morning temperature was normal, and after ten days the afternoon temperature also became normal. The leucocyte count dropped from 12,650 to 10,400; the hemoglobin was 67 per cent; the erythrocyte count was 3,440,000. Urinalysis showed no abnormal findings. The wound drained only a small amount of serum for a few days and healed without difficulty. On the tenth day the patient returned home. Six weeks later the cast was changed and a roentgenogram taken at the time showed a large cavity in the femur as well as a destructive arthritis of the hip, and the child was treated for tuberculosis of the hip. The hip remained free of pain and the child's general condition improved. She has been able to go to school and her development has been quite normal. The hip is in excellent position, no apparent shortening is present, and the roentgenogram shows the process arrested.

The patient thus presented an example of a bone infection near a joint, where the infection was tuberculous in origin and

broke through to invade the hip joint to cause a destructive arthritis. Bone infections near the joint were discussed by Adrieu at the Eleventh French Orthopedic Congress in 1929. They were found to occur almost always below the eighteenth year, and most frequently in children from five to twelve years of age. Tuberculosis was the most common cause of the lesion. The hip, shoulder, knee, elbow, wrist and hand may be involved, and at times the lesions are multiple. In young children the epiphyseal disc acts as a protection against invasion into the joint. Adrieu also stated that the early symptoms were not characteristic, the pain varied a great deal, and disturbance in function was slight. The lesions in his experience never healed in less than one and a half years. His treatment consisted of absolute immobilization. If the lesion were definitely localized he urged an early operation to prevent invasion of the joint. He excluded involvement near the hip joint from this rule. In a discussion of the same subject, Froelich spoke in favor of conservative treatment. Sorrel operates only when the diagnosis is positively established. Nove-Josseraud tries conservative measures first and operates only when the joint is threatened by invasion. Rocher is in favor of an operation to save the joint but adds that the time for healing is not shortened by the operation. Martin du Pau advises the use of Masetig-plumbe (an iodoform-quajacol mixture), while Roederer lets the clinical findings of the individual case guide him as to whether or not an operation is indicated.



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EDITORIALS

IN the public press there appeared the statement of a physician of international fame to the effect that the current business depression has reacted favorably on the public health. The argument advanced was that since people could not indulge in luxuries that go hand in hand with boom times and since, due to lack of funds, many people were forced to go on simple, sparse diets, and instead of riding in automobiles, were walking to their places of appointment, the general health of the people was much improved. The conclusion drawn was that while these days might be troublesome ones to those engaged in the business of the nation, yet "the bright ray in the darkness" was that people were healthier than they had been in many years.

We doubt the accuracy of these theories and conclusions. It is a fact that the private and semi-private hospitals throughout the country have had a low census during the past year or eighteen months. On the other hand, the beds in charity hospitals have been filled and in many places there are waiting lists for those who wish to enter the institution for treatment. It is reasonable to assume that, good times or bad, people are suffering the ills common to mankind. Great strides have been made in preventive medicine and periodical health examinations have a strong foothold in the minds of the laity, but in times of depression one does not seek a physician unless he knows that he is ill. Only a man with a surplus in his pocketbook seriously turns to measures of prevention.

There is less surgery being done today than formerly, but no doubt there are thousands who will be operated on in the future because they did not have the mind and means to seek medical guidance at the present time.

It would be interesting to know whether, in two, three or five years from now, the percentage of cancer cases will show a vast increase, and we wonder if there are not many women who will be operated on for

pelvic disorders that today could be so treated medically as to prevent future surgery. This holds true for the whole realm of surgical conditions. We feel that at the present time not only do conditions affect the pocketbooks of the people but they are neglecting their health, and the price they will pay in future complications will be heavy.

T. S. W.





AMERICAN PHYSICIANS

EPHRAIM McDOWELL

EPHRAIM McDowell, the father of gynecology, was born November 11, 1771 in Rockbridge Co., W. Va., of sturdy Presbyterian stock. He was the ninth of twelve children. After the Revolution, the family moved to Danville, Ky.

Ephraim's early education was meager. At the age of twenty he decided to be a physician. He returned to Virginia and entered the family of a Dr. Humphreys, of Staunton. After two years with this busy gentleman of mediocre talent he went to Edinburgh and began formal study. Here he remained two years. John Bell was his hero. Funds were not too plentiful, so Ephraim never took his degree, but returned home in 1795. He started practice in Danville, and was swamped with "a great burden of practice." For years he was the only surgeon in the state.

In 1809, when thirty-eight years old and after fourteen years in practice, he performed ovariectomy. A Mrs. Crawford consulted him for what was diagnosed as a large ovarian tumor. McDowell had already made up his mind, as a result of Bell's fundamental teaching, what he would do whenever confronted with such a problem. McDowell and his nephew, James, operated on her. There was no preoperative preparation beyond giving Mrs. Crawford a large dose of opium. "The patient being on the table, I marked with a pen the course of incision to be made; desiring him [nephew James] to make the external opening. I then took the knife, and completed the operation, as stated in the *Medical Repertory*. Although the termination of this case was most flattering, yet I was more ready to

attribute it to accident than to any skill or judgment of my own; but it emboldened me to undertake similar cases; and not until I had operated three times . . . did I publish anything on the subject. I then thought it due my own reputation and to suffering humanity to throw all light which I possessed upon diseased ovaria."

McDowell sent a copy of his article to Bell in Edinburgh, and other copies to Wm. McDowell, his nephew and physician, and to Physick in Philadelphia. Physick never acknowledged its receipt. The nephew, however, took the story to Thomas C. James, and as a result, promptly published it in the *Eclectic Repertory*. The published cases were either unnoticed or not believed. The account sent to Bell fell into the hands of a Mr. Lizars, an Edinburgh surgeon, who was much impressed. The paper was published in the *Edinburgh Medical and Surgical Journal*. It was received with scorn. Before long, however, its value and worth were recognized. McDowell became a name throughout the medical world.

There is some discussion as to the total number of ovariectomies McDowell did. The number has been put at 13. We know 8 patients recovered.

In 1802 he married Sarah Shelby. They had eight children. In 1807 the Medical Society of Philadelphia sent him its diploma. In 1825 the University of Maryland made him an alumnus with the honorary M.D. After a short illness Ephraim McDowell died on June 20, 1830.

T. S. W.



EPHRAIM McDOWELL

[[1771-1830]]

BIOGRAPHICAL BREVITIES
"American Physicians"

The American Journal of Surgery
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[From Fernelius' *Universa Medicina*, Geneva, 1679.]

BOOKSHELF BROWSING

VIVISECTION AND OBSTETRICS*

J. P. GREENHILL, B.S., M.D., F.A.C.S.

CHICAGO

INTRODUCTION

ANIMAL experimentation has yielded an enormous amount of valuable information to obstetrics. To enumerate all these contributions is manifestly impossible, hence an effort has been made to select only the most important ones.

GLANDS OF INTERNAL SECRETION

By glands of internal secretion we mean glands whose specific products are transmitted directly to the blood or lymph instead of being carried to the exterior by a duct. In this group of glands are the following: ovaries, hypophysis or pituitary gland, thyroid, parathyroids, pancreas, adrenal glands, thymus, and placenta. Experiments on the glands of internal secretion have been performed in large numbers, especially during the last two decades. A fair proportion of this effort has been expended on pregnant animals.

OVARIES

The most important organs in women, from the point of view of the propagation of the human race, are the ovaries. Without ovaries, reproduction is impossible. Etienne Miroslaw, Grigorieff, Knauer, Francis H.

A. Marshall and others have successfully transplanted the ovaries of animals from their original positions to other parts of the body. Joseph A. Long (1879) and H. M. Evans demonstrated that the ovaries of immature white rats can be transplanted into adult rats and there begin to function. Furthermore, W. E. Castle and others have transplanted ovaries from one animal to another of the same species, so that pregnancy followed the operations. In human beings transplantation of ovaries is still in the experimental stage, but the results so far obtained are encouraging.

Two ovaries are normally present, but a woman may be just as prolific if she has only one. Reproduction is the most important function of the ovaries. Furthermore, it is not the entire ovary which participates in the process of reproduction, but small yellow bodies, each of which is known as a *corpus luteum*. These bodies are due to the growth of so-called Graafian follicles, first described in 1672 by Reijnier De Graaf (1641-73), who demonstrated these vesicles in the ovaries and fallopian tubes of rabbits. One of these follicles originates as a group of cells and grows into a differentiated sac which con-

* This is the second of a series of articles on the value of animal experimentation in medical progress. The next article will appear in an early issue.

tains the egg, surrounded by fluid called the *liquor folliculi*. When the follicle bursts the egg or ovum is extruded and usually finds its way into one of two Fallopian tubes which lead directly to the cavity of the womb. In the Fallopian tube the ovum may be fertilized by a spermatozoon. In mammals, so far as is known, fertilization always takes place in the Fallopian tubes. According to George W. Corner the fertilized ovum proceeds exactly as the unfertilized one into the uterus on the fourth day, and this period of time is the same regardless of the widely variant length of the Fallopian tube in a number of different species of mammals. In mammals the ovum has an extremely short life, as shown by Hartman (1924) and Grosser (1924); hence the spermatozoon must fertilize the ovum within a few hours. After the expulsion of the ovum, the follicle in the ovary undergoes certain changes and becomes a corpus luteum. Normally there is only one fully developed corpus luteum present at any one time and it may be found in either the right or the left ovary.

A. Sokoloff (1861) was one of the first to experiment on the influence of extirpation of the ovaries during pregnancy. In 1896 he reported experiments on dogs which showed that removal of the ovaries early in pregnancy resulted in the absorption of the embryos; and he concluded that the ovary or the yellow body maintained the receptivity of the uterus for the development of an ovum. Fraenkel in 1903 advanced the hypothesis that the corpus luteum is responsible for the elaboration of a secretion which controls menstruation and the implantation of a fertilized ovum in the uterus. In 1910 he published his experimental work on rabbits in support of his theory. Leo Loeb whose experiments on this subject were performed on rabbits between 1907 and 1917 discovered the specific effect of the corpus luteum. He showed that the latter secreted a substance which sensitizes the lining of the womb so that it is changed into a

layer, known as the *decidua*, which is capable of forming the placenta or after-birth. He showed that if a foreign body is introduced into the uterus, the lining of the womb in contact with this foreign body assumes a decidual character provided there is a corpus luteum present. If there is no yellow body there is no reaction even after injection of ovarian extract. Albert P. Ancel (1873) and Paul Bouin (1870) performed similar experiments. Other experimenters who confirmed this work are Corner and Warren, R. Frank, and Long and Evans. Allen and Doisy injected the follicle fluid obtained from adult rats into immature albino rats and produced premature puberty. Allen, Pratt and Doisy and also Frank and his co-workers obtained a hormone from the follicle fluid, the corpus luteum and the placenta. Frank and Gustavson call this hormone the female sex hormone. Frank found that when this hormone is injected into immature female white rats it produces premature puberty and sexual maturity. Frank and Goldberger isolated this hormone from the circulating blood of women. They contend that the blood may be tested for the female sex hormone and thereby aid in the diagnosis of early pregnancy, the death of a fetus after the twelfth week, and the determination of sex in the presence of malformation or pseudohermaphroditism.

The general consensus of opinion is that menstruation is impossible without a corpus luteum but Corner has recently proven that in monkeys and also in the human being menstruation is possible without the yellow body. Pregnancy however is absolutely dependent upon the presence of mature follicles which contain the eggs and which are the fore-runners of corpora lutea.

In 1906 Marshall and Jolly confirmed Fraenkel's hypothesis by showing that spaying of dogs early in pregnancy caused death of the embryos and their resorption in the uterus. Hartman showed that in the opossum, removal of one ovary was

without effect on pregnancy but removal of both ovaries early in pregnancy invariably caused the death of the embryos. Nevertheless subsequent to the firm implantation of the ovum, the development of the fetus does not depend upon the corpus luteum, as shown by Kleinhaus and Schenk. Allen, Pratt and Doisy believe that the corpus luteum may be excised from a woman as early as twenty days after the last menstruation without interfering with normal gestation; but this is most exceptional. Walter Heape (1855) and Marshall studied in detail the anatomy of the oestrus cycle ("heat") in monkeys and many other animals and concluded that menstruation in women and in monkeys is analogous to the preoestrus in the lower animals.

In 1844 Bischoff demonstrated in rabbits the manner in which the ova escaped from the mature follicles and wandered into the Fallopian tubes. In 1880 Leopold showed that ova can travel a long distance and enter the tube on the side opposite the ovary from which they were expelled. This phenomenon has since been repeatedly shown to occur in the human. Corner and his associates have shown that there is a definite relationship between rhythmic contractions of the Fallopian tubes and the menstrual cycle, both of which depend upon the function of the ovaries. Wislocki and Guttmacher produced tubal contractions experimentally in pigs, and Keye and also Seckinger showed that these rhythmic contractions aid in the transportation of fertilized ova to the uterine cavity. Kok studied this phenomenon in cows, sheep, pigs and also human beings. He believes that the contractions of the tubes play an important part not only in the conveyance of fertilized eggs normally, but also in the condition known as tubal pregnancy in which the fertilized ovum remains in the tube, and sooner or later necessitates an abdominal operation in most instances.

Rubin insufflated the uteri of pigs with oxygen and observed rhythmic contrac-

tions of the tubes. Further experiments along these lines led him to his monumental contribution to medicine, namely a test whereby the patency of a woman's Fallopian tubes may safely and easily be determined without an operation. The Rubin test is not only a form of examination but also a therapeutic measure in the treatment of sterility, for a considerable number of women become pregnant soon after the test is performed.

HYPOPHYSIS OR PITUITARY GLAND

The hypophysis or pituitary gland is next to the ovaries the most important gland in the reproductive function. This gland is small, made up of two parts, one of which is continuous with the brain. Aschner extirpated this gland from pregnant dogs and found that all of them aborted. Harvey Cushing in 1912 also found this to be true but he demonstrated that no ill effects follow the extirpation of only part of this gland. Recently the deaths in the cases of complete extirpation have been attributed not to the removal of the hypophysis but to injury of a near-by important structure, the hypothalamus.

It was shown by Compté in 1898, that the hypophysis undergoes a marked hypertrophy during pregnancy, and the anterior lobe is exclusively responsible for this increase in weight. In women Cushing found that repeated pregnancies may cause such an enlargement of this gland that a transient, partial blindness may be produced by pressure of the gland on the large nerves which supply the eyes. Tandler and Gross pointed out that in some pregnant women there are abnormal manifestations of overactivity of the pituitary gland such as coarseness of the facial features, especially of the nose and lips and a thickening of the hands.

In 1909 a most important discovery was made concerning the hypophysis. H. H. Dale and also Fröhlich and V. Frankl-Hochwart found that administration of extracts of the hypophysis to experimental animals produced contractions of the

uterus during pregnancy and lactation. During the same year W. B. Bell injected pituitary extract into women and found that the result was the same as in the cat, dog, guinea pig and rabbit. Two years later J. Hofbauer reported very good results with these preparations and since that time preparations of the pituitary body have been used on an enormous scale in obstetrics. The outcome has been that not only has a great deal of benefit resulted from these preparations, but also much damage. The extracts when improperly used are productive of great harm but when properly applied are a great blessing. At present pituitary preparations are successfully used to initiate delivery, to accelerate labor under certain conditions, to control hemorrhage, to cause the uterus to contract at the time of a cesarean section, and to bring about the expulsion of the fetus and afterbirth which remain in the womb after a miscarriage.

We do not know the exact cause of the onset of labor but most likely the pituitary gland is at least partly responsible and this belief is the basis for the use of pituitary preparations for starting labor contractions. Dixon and Francis H. A. Marshall (1878) have shown experimentally that the ovarian secretion activates the pituitary gland, and that the latter in turn produces uterine contractions, thus having an important bearing on the onset of labor. Recently Jerlov (1926) performed a series of experiments on guinea-pigs and came to the conclusion that the stimulus for labor under normal conditions originates in the fetus.

Knaus in 1927 found that repeated injections of pituitary extract into pregnant rabbits early in pregnancy uniformly failed to disturb the gestation, but injections given late in pregnancy invariably resulted in delivery. These results may be paralleled in human beings, for it has been found that the nearer the time of the actual birth of the child, the more potent are the pituitary preparations. However, if abnormal contractions of the uterus are present

in the early months as in cases of incomplete miscarriage, pituitary extract has a definite stimulating effect.

Aschheim and Zondek, who have done an enormous amount of valuable experimental work, were able to isolate hormones from the ovaries and from the hypophysis. They found that the pituitary hormones were greatly increased during pregnancy and were excreted in the urine. The animal experiments of the authors culminated in one of the most brilliant and practical advances made in this century, namely, a simple and reliable test for early pregnancy. Thanks to these investigations, pregnancy may now be detected as early as three days after the first menstrual period is missed.

THYROID GLAND

In 1896 Halstead showed that dogs in whom part of the thyroid gland had been removed were normal until they became pregnant. Then they showed symptoms of great deficiency in the secretion from the thyroid gland, and the symptoms disappeared after the birth of the puppies. These experiments proved that gestation leads to increased demands upon thyroid secretion. Halstead's work was confirmed by Marine and Lenhart in 1909. The latter investigators showed that when there was sufficient iodine in the diet, there was no increase in the size of the thyroids of their pregnant animals and the young were not born with goiters. Later when these same animals were placed upon a diet deficient in iodine the thyroid glands increased in size during pregnancy and some of the offspring had congenital goiters. The same phenomenon has been observed in human beings.

PARATHYROID GLANDS

Following the work of Frommer in 1906 and Adler and Thaler in 1908, it was shown that tetany (a disease characterized by painful, muscular spasms and paralysis, and often fatal) is due to absence or greatly defective secretion of small bodies

known as parathyroid glands. These glands are situated behind and are contiguous with the thyroid gland. They increase in size during pregnancy. Frommer, and Adler and Thaler found that in white rats portions of these glands may be removed without effect but when these animals become pregnant tetany develops. Luckhardt and Rosenbloom in 1922 showed that if the parathyroid glands are entirely removed from both pregnant and non-pregnant dogs, the dogs die within twenty-four to ninety-six hours. However, the dogs can be kept alive if given Ringer solution intravenously. The Ringer solution may be discontinued after forty to sixty days, and the animals will then remain alive and will not exhibit tetany. Lisser, Smith and Shepardson cured a patient who had tetany during pregnancy by means of parathyroid hormone. Dragsted and his co-workers have indicated the close connection between eclampsia (convulsions) in women and the toxemia which occurs during pregnancy in dogs in which the parathyroid glands have been removed.

PANCREAS

Diabetes is a fairly common disease. Because of the discovery of insulin a few years ago, much has been written about this illness even in lay magazines and newspapers and most laymen now know that the affliction is due to a disturbance in the internal secretion of the gland known as the pancreas. A large proportion of women who have diabetes are sterile and many more who become pregnant have miscarriages. Usually pregnancy in a diabetic woman aggravates the diabetes, hence pregnancy has frequently had to be interrupted. Since the advent of insulin, termination of gestation for diabetes has been infrequent. Experiments on dogs by Carlson and Drennan in 1911 yielded very interesting results. They found that in a normally developed fetus nearing the time of birth, the pancreas is so developed both qualitatively

and quantitatively as regards the internal secretion necessary for normal sugar metabolism that the fetal pancreas acts as a residual pancreas of the mother when the entire pancreas has been removed from the latter. The internal secretion of the fetus passes through the uterine membranes in sufficient quantity to prevent diabetes in the mother.

ADRENAL GLANDS

There is experimental evidence to show that the adrenal or suprarenal glands also increase their activity during pregnancy. This augmentation is the cause of the increased pigmentation on the face, the nipples and the abdomen during pregnancy, and it also explains the exaggerated growth of hair frequently seen in pregnant women. Halban in 1903 demonstrated this increased growth of hair in animals.

Cybulsky demonstrated that the suprarenal gland through its secretion maintained the tonus of the muscular tissues of the body. Hence perhaps hyperactivity of this gland may be associated with the beginning of labor. O. Kamoto showed that adrenalin, the hormone of the suprarenal gland, excites the uterus of the cat, rabbit and guinea pig and inhibits the uterus of the rat. Recently Rucker showed that adrenalin also inhibits uterine contractions in women and it can therefore be used with great advantage in certain spastic conditions of the uterus.

PLACENTA OR AFTERBIRTH

The placenta or "afterbirth" is the organ by which a fetus is nourished while it is in the womb. The organ performs many functions such as digestion, respiration and excretion and hence is of vital importance. It is intimately connected with the specialized lining of the womb, the decidua, and if for some reason a large part of the placenta is destroyed or separated from its connection with the lining of the womb the child dies. Many animals devour the afterbirth immediately after they give birth. Hartman (1928),

who for the first time gives an exact account of gestation in monkeys, noted this phenomenon in his cases. In about a dozen monkeys he observed a marked reddening of the hips and buttocks ("the sex skin") during pregnancy, and this discoloration he attributes to the placental hormone. This same reddening was produced experimentally by Allen (1927) during the menstrual cycle and is due at this time to the hormone from the follicles in the ovaries.

BREASTS

The conditions which control the secretion of milk in the breasts have been the subject of much experimental work. The ovaries undoubtedly have an effect upon the breasts, since complete removal of the ovaries is followed by atrophy of the mammary glands. However, Mironow in 1894 proved that after apparently complete separation of the breasts from all their extrinsic nerves not only does the flow of milk, if it was previously present, continue, but in operations of this kind upon pregnant animals the glands increase in size during pregnancy and become functional after childbirth.

TRANSMISSION OF SUBSTANCES FROM MOTHER TO OFFSPRING AND VICE VERSA

In 1892 Paul Ehrlich (1854-1914) demonstrated the passage of immune substances through the breast milk of the mouse. However, later observers showed that while this was true for ruminants it did not hold good for the human being. Ratner, Jackson and Gruehl, and Kuttner and Ratner have shown that in the guinea pig and the human being, substances pass from the mother to the offspring through the placenta but not through the milk. These authors corroborated earlier work of Rosenau and Anderson. Mother guinea pigs were sensitized with horse serum before pregnancy and all the offspring born of these mothers were sensitive at the time of birth. As soon as brought in contact

with horse serum given in the vein, the offspring died in acute anaphylaxis or developed severe anaphylactic reactions. This transfer of protein hypersensitiveness was passive and lasted for only three months, exactly the length of time that passively transferred immunity would persist, and it could not be transferred to a second generation. These authors also showed that it was possible to sensitize a fetus while in the uterus of a mother who at the time of parturition was herself not sensitive. Since the permeability of the afterbirth in the guinea-pig and the human being are alike, the authors believe this active immunization in the womb explains the bizarre manifestations of infants when they come in contact with certain foods for the first time. These studies make physicians pay particular attention to any excess or cravings in a woman's diet during pregnancy and toward the influence that any injections given during pregnancy may have on the future sensitization of an unborn child.

A most fascinating series of experiments was performed by Sauerbruck and Heyde in 1910, after the publication of Basch on the famous Blatscheck sisters who were twins united at the hips. These investigators united rats to one another in such a way that they continued to live. If both animals were pregnant the occurrence of labor pains in one started a similar process in the other. If however, only one was pregnant, the initiation of labor pains in the gravid rat produced a serious illness in the other non-pregnant one. These observations according to the experimenters show that the cause of labor must be some substance which circulates in the blood and which is harmless to pregnant animals but poisonous to non-pregnant animals. However, Kross recently performed experiments on rats but could not verify these results.

STERILITY

Approximately 10 per cent of all marriages are sterile, hence sterility is a very

important problem. In recent years the question of diet as a cause of sterility has been extensively studied in animals. Herbert M. Evans and Burr have conclusively shown that certain vitamins are essential for fertility. They have shown that in rats vitamin E is an absolute necessity to prevent sterility. Well-known sources of this vitamin are wheat germ and butter. However, if substances containing this vitamin are mixed with large amounts of certain fats such as lard the effectiveness of the vitamin is destroyed. Reynolds and Macomber, who likewise studied the effect of the diet on the fertility of rats, conclude that the prolonged use of a defective diet may so effect the vitality of the germ cells that the product of conception will be able to attain only a certain stage of development before succumbing.

It is a common observation that very obese women are sterile but experiments on rats by Parkes and Drummond showed that an excessive degree of fatness does not necessarily lead to sterility and that fatness is more frequently a result than a cause of sterility.

Dittler (1920), McCartney (1923), Kovacs (1925), and others have been able to produce temporary sterility in rats by means of injecting the spermatozoa of the male into the female. As yet this method is not applicable for humans.

Not infrequently the desirability arises for inducing permanent sterilization of a woman. The fact that 42 operations have been devised for this procedure proves that not one of them is perfect. Most of the procedures aim at shutting off the lumen of the Fallopian tubes but the animal experiments of Fraenkel have shown that in a large proportion of cases the tubes regain their patency after operation.

MISCARRIAGE OR ABORTION

Closely allied to the question of sterility is that of miscarriage. As yet we do not know the cause of the majority of spontaneous early abortions. Hellendall in

1906 experimentally produced abortions in animals by means of bacterial injections. He showed that abortion followed infection of the contents of the pregnant uterus and that this infection may occur by three routes, first by way of the vagina, second by way of the mother's blood stream, and thirdly from the abdominal cavity by way of the Fallopian tubes as in cases of appendicitis. These three mechanisms are responsible for infection in the womb at any time of pregnancy or labor. Although all three means of contaminating the uterus occur in the human, the first one is the one most frequently encountered. This means that the physician must be extremely careful to avoid forcing bacteria into the vagina or uterus during his manipulations in this region.

Nickel and Mussey (1927) produced abortions in pregnant guinea pigs by injecting into these animals bacteria found in the tonsils and teeth of women who had had spontaneous miscarriages. This work confirmed that done by De Lee and Curtis on rabbits twenty years previously.

ACTION OF X-RAYS AND RADIUM ON THE FETUS

An enormous amount of experimental work has been done on this subject. In 1903 Bohn was one of the first to report abnormal development in the sea urchin after exposure of the eggs to the x-rays. Similar observations were made by Perthes on the ova of worms. The work of Richard Hertwig, O. Hertwig and G. Hertwig in this field are monumental. They proved that in amphibians retardation of embryonic development followed irradiation. Normal fertilized eggs subjected to radium produced deformed larvae and the extent of the deformity depended upon the amount of radium used and the duration of its action. Schaper confirmed this work and Tur reported deformities in the embryos of birds subjected to radium through the egg shell. Halsey Bagg found that pregnant rats when irradiated with

radium emanation near the end of pregnancy produced offspring that either died about ten days after treatment, or, if the young were alive after this period, they showed markedly deformed brains, blindness and sterility in both sexes.

The effects of exposure to the x-rays upon animal development are similar to those of radium. Perthes found monsters in the embryos of worms exposed to x-rays; Bordier noted abnormalities in silk worms, Gilman and Baetjer in amphibians and Baldwin in frogs. Hippel and Pagensteicher subjected pregnant dogs to x-rays and produced death and abortion of the embryos or cataracts in the eyes of the offspring. Regaud, Nogier and Lacassagne, Cohn Lengfellner, Krukenberg, Walter and also Little and Bagg likewise produced fetal abnormalities by submitting pregnant animals to the x-rays. All these experiments indicate that if irradiation occurs early in pregnancy, the fetus may be so injured that it dies and is aborted, or it may be born alive and show marked abnormalities. However, if the radiation is given late in pregnancy, the results may be of an insidious nature so that a normally-appearing offspring at birth may be stunted and show disturbances later in life. In recent years there have been clinical reports from physicians which show that where radium or x-ray was used early in pregnancy, great disturbances in the offspring were noted. In many cases, death and abortion of the fetuses have occurred. Irradiation late in pregnancy does not have the same tendency to produce gross developmental abnormalities in the child but at least some children subjected to radiation late in pregnancy have been born prematurely or have shown disturbances after birth. From the foregoing we may conclude that the therapeutic use of radium or x-rays in the region of the womb during pregnancy is fraught with great danger to the child in the womb. This danger, however, does not exist when one or a few x-ray pictures are taken during pregnancy because in these in-

stances the exposure to the x-rays seldom last more than a few seconds at any one time.

A question of great interest is the following: Will a woman in whom a temporary cessation of the menstrual flow has been produced by the x-rays or radium give birth to abnormal babies after the return of menstruation? According to Wintz (1928) animal experiments have failed to prove definitely that abnormal fetuses are born after the return of the oestrus cycle which was suppressed by radiation. Likewise in women there is no unequivocal proof that x-rays or radium so injure unfertilized ova that damaged offspring will subsequently result when these ova are fertilized.

MONSTROSITIES AND TWINS

Much experimental work has been done on the production of monsters, notably by Child, and Stockard, both of whom seem to have discovered the same phenomena at about the same time. Stockard after many years of experimental work chiefly on fish came to the conclusion that changes in the conditions of moisture, temperature and oxygen supply in the environment of the developing embryos are the most frequent causes of embryonic death as well as of monstrous development. The primary cause of all abnormal developments is reduced by Stockard to a single factor, namely developmental inhibition or arrest. The type of deformity that results depends solely upon the exact moment when the interruption in development occurs. This author has produced different types of monsters at will by changing the time at which the retarding influences were brought into play. He has adduced experimental proof that there is a close relationship between identical twins and double monsters. Arey believes that Stockard's concepts apply equally to human abnormalities and twins. Newman who has done an enormous amount of experimental work on fish, worms, birds, etc., maintains for the armadillo at least, that

the essential feature of twinning is temporary cessation or radical retardation of development at a critical period. The nine-banded armadillo as first shown by Newman and Patterson in 1909 habitually gives birth to a litter of four offspring all of which are of the same sex and are strikingly alike. Other individuals who performed important work on monsters are Bellamy, Dareste, Gemmill and Kaestner.

Greenhill in 1923 attempted to correlate the association of monsters with a condition known as placenta previa in which the afterbirth is in the way of the exit of the child from the womb. This condition is usually a very serious one and causes the death of many women due to hemorrhage, infection and lacerations.

ANALGESIA AND ANESTHESIA DURING LABOR

As far back as history goes, notations have been made concerning the painfulness of childbirth, hence pain during the delivery of a child has been accepted as a normal phenomenon. In fact the contractions of the womb which produce the expulsion of the child are called "labor pains." Practically the only labors which are painless are those during which patients are given drugs or anesthetics.

In the first stage of labor, that is the period during which the womb prepares itself to expel the child, women are generally given drugs such as morphine, pantopon, scopolamin, atropin, heroin, magnesium sulphate, etc., which are given hypodermically and are known as analgesic drugs. These substances are helpful for they relieve most of the pain during labor. The most recent method advocated for rendering childbirth painless is known as the Gwathmey synergistic analgesia method and consists of hypodermic injections of morphine and magnesium sulphate and rectal instillations of ether, alcohol, quinine and oil. Animal experiments were performed to perfect this technique which is now extensively used.

In the second stage of labor, that is the period when the child is actually

born, the pain is at its height and it is at this time that an anesthetic is given. The anesthetics generally used are chloroform, ether, nitrous oxide and oxygen, ethylene and oxygen and some form of local anesthesia. Sir James Y. Simpson in 1847 introduced the use of chloroform into obstetrics. Most women are now given an anesthetic during childbirth. At present chloroform is the one most infrequently used of all the inhalation anesthetics, because it has been found to be the most dangerous of all anesthetics. This was shown experimentally in pregnant dogs by Howland and Richards in 1909, Whipple and Sperry in 1909 and Whipple in 1912. More recently Stander, also experimenting with dogs, showed that damage to the organs was caused not only by chloroform but also by the other inhalation anesthetics as well. Furthermore, the injury found in the liver was similar to that produced by eclampsia, a disease of pregnancy and labor characterized by the layman as "convulsions" and one which exacts about 5000 lives every year in the United States alone. Boshamer also proved the harmfulness of ether on the human liver, hence nowadays we make every effort to employ some form of local anesthesia, especially in cases of eclampsia and the toxemias of pregnancy which may lead to eclampsia.

CHILDBED FEVER OR PUERPERAL SEPSIS

Childbed fever is a condition which causes the death of at least 6000 women every year in this country. Usually in this disease there are bacteria in the blood stream and efforts have been made to kill these bacteria with various drugs, chemicals and other means without, of course, harming the woman. Thus far the results have not been satisfactory. The most recent drug, mercurochrome, advocated by Young and White, and used extensively a few years ago, is not without danger when given intravenously. Since in most cases the organism known as the streptococcus is responsible for death in cases of

puerperal sepsis, many individuals have used some type of antistreptococcus serum. However, the results of serum therapy are not satisfactory. Tavel, Menzer and Aronson have each shown by means of animal experimentation that the serum used does not neutralize the bacterial toxins but merely produces conditions which increase the powers of resistance of the body.

DIET

It has always been of great interest to find out what effect the quantity or quality of the mother's food has on the offspring. Iron is of the utmost importance to the fetus and Fetzer in 1913 experimenting with rabbits showed that the amount of iron contained in the fetal tissue varies with the amount of iron in the mother's food. When the quantity of iron in the mother's diet falls below a certain minimum, the amount which is essential for the welfare of the fetus is taken from the maternal tissues. Zuntz in 1919 demonstrated in animals that during pregnancy a diet which was markedly deficient in one or more of the important constituents had no effect upon the weight of the offspring, but such animals were relatively sterile. Reynolds and Macomber in 1921 confirmed this work, but the original experiments were performed by Emmerich and Loew who in 1915 showed that calcium when fed to mice, guinea pigs and rabbits increased their fecundity.

There is a common belief among the laity that restricted dieting during pregnancy will bring about the birth of a small baby. Some physicians believe the same and many diets have been advocated for this purpose, notably that of Prochownick, a Russian. Slemons and Fagan and also Friedman have recently reported a reduction in the size of babies born of mothers who had been placed on a restricted diet. However, a marked reduction in the size of the baby cannot often be brought about by reducing the mother's diet. During the recent war, in spite of the prevalence of hunger and almost starva-

tion in Germany, the babies born weighed just as much on the average as babies born before the war. We must nevertheless remember that overeating or excessive gain in weight during the second half of pregnancy is harmful, but chiefly because of its evil effect upon the mother and only indirectly on the child.

It is well known that early in pregnancy women often show lassitude, mental depression and loss of weight and that later during gestation the women feel very well both in mind and body. This phenomenon has also been observed in guinea pigs, dogs and rabbits by Hagemann Ver Eecke, Jägersroos, Murlin and especially by Bar. The excellent metabolic studies of Bar showed definitely that in pregnant dogs there is a storage of food in the second half of pregnancy which is more than sufficient for the needs of the fetuses, the afterbirths and their accessories. Hence, in the second half of pregnancy the mother gains and does not sacrifice herself for the sake of the species. Stander, Duncan and Sisson have shown that in dogs the heart performs much more work during pregnancy.

CONCLUSIONS

It is generally agreed that the knowledge of obstetrics today is very considerable but it is insignificant compared to what is still to be learned. As in the past, the solution of many unsolved problems in this field will come only from experiments upon animals. It may not be amiss to discuss briefly a few of the important problems.

The large question of involuntary sterility is just beginning to be studied. So much unhappiness is caused by infertility that it is imperative we obtain more knowledge with which to combat this condition. Many factors in sterility which are now being studied are the biochemistry, physiology and microscopic anatomy of the reproductive organs, the constitution of the individual, the compatibility of the blood of husband and wife, artificial

insemination, the effect of diet and the use of the x-rays and radium. Hand in hand with the question of involuntary sterility is the matter of intentional infertility.

The matter of the determination of sex has a fascination for every one, lay persons as well as medical. Many individuals have devised methods of predicting the sex of a child before it is born but until the present time no method has been found reliable. Lüttge and von Mertz who have been using a chemical test of the mother's blood, claim to be able to predict the sex of an unborn child in almost every instance. Corroborative evidence of other investigators has failed to verify all the claims of the original experimenters but the test gives promise of being reliable when perfected.

The controlling factor in the determination of sex resides in the male element, as has been proved in an endless number of experiments on animals. In the latter, sex can be predetermined experimentally and animals may be changed from one sex to the other. Thus Witschi altered the temperature in which tadpoles were developing and the sex glands of the females gradually assumed a masculine character and the frogs emerged as males. Whether the sex can, and if possible should be, predetermined in humans is a question for the future to decide.

The cause of spontaneous abortions and miscarriages is unknown in most instances. The male partner is undoubtedly responsible for some miscarriages, but at present we have practically no way of proving this in the majority of cases for human beings. In domestic animals however, especially cattle, a great deal is known about the defectiveness of the male.

Not infrequently when babies are born dead near the end of pregnancy or die soon after birth, we can find no apparent cause for the death. New lines of investigation are necessary to solve these mysteries. Many babies that go beyond the normal

time of confinement die before they are born but we do not as yet know why this occurs. Likewise we know comparatively little concerning the cause (except the small proportion due to syphilis), and almost nothing about the prevention of monstrosities. We have also much to learn concerning pregnancies which occur outside the womb.

Another and more important question which must be solved is why at a certain more or less specific time labor pains begin and a child is born. At present we have good reason to believe the stimulus for this activity comes from the hypophysis but we have not definitely isolated the substance which initiates the contractions of the womb. Because of this we have no safe and certain method of inducing labor when this becomes necessary.

Another large field for work is offered by the placenta and the bag of waters which surrounds the child in the womb. The amount of knowledge we possess today concerning the afterbirth, the membranes and fluid is infinitesimal compared with what we can still learn about these structures.

Douglas, a Scotchman said, "The pregnant woman ipso facto is apt to die," and many individuals believe this is true. Childbirth today, just as it always has been is associated with a certain amount of practically unavoidable damage to both mother and child. No other normal function of the human body is attended by so much injury. Why this should be we do not know, neither can we explain as yet why the blood of pregnant women shows certain reactions analogous to those shown only by the blood in infectious diseases and in cancer.

There could be mentioned many more problems which need elucidation but the foregoing brief review indicates that there are enough unsolved problems in obstetrics to keep those interested in research well occupied for many years. For the solution of most of these problems animal experimentation is absolutely essential.

BOOK REVIEWS

MEDICINE, SCIENCE AND ART, STUDIES IN INTERRELATIONS. By Alfred E. Cohn, M.D. Univ. Chicago Press, 1931, 212 pp.

This volume comprises the following six papers: "The Difference Between Art and Science in their Relation to Nature"; "The Development of the Harveian Circulation"; "Purposes in Medical Research"; "Medicine and Science"; "Physiology and Medicine"; "The Hierarchy of Medicine." They represent the authors' opinions along lines that have furnished food for thought for philosophers through the ages. Criticism or even discussion is rather disarmed by the author's frank statement that: "The chief reason for writing them [these essays] was to make clear to myself the views and opinions and the systematic relations of these bits of the world, at least, which required ordering within my own mind. Each having been for many years the subject of much inquiring. I welcomed occasions, as they arose, to reduce what I had to say to a form in which I could test the validity of my thought. If I share them now in this form, I do so for reasons which are common to all men but which I prefer not to disclose. Under the circumstances I need not protest that writing them has been a pleasure." And at the conclusion of his preface, after thanking his publishers, he makes a statement regarding them which we believe will also describe the feeling of the average reader of the book "their kindly and somewhat amused sympathy with the vagaries of an amateur author are quite beyond my praise."

Dr. Cohn has opinions of his own and is not afraid to express them. He has a wide acquaintance with the scientific literature of the ages but is in no sense a meek follower of authority or tradition. His writings are such as to stimulate his reader's imagination and encourage individual thinking, and we sincerely hope that he will have in his heart the same "kindly and somewhat amused sympathy with the vagaries of the amateur" reader (who may find difficulty in following all his rather profound and heavy lucubrations), that he bespeaks for himself as an author. The publishers are entitled to more than passing praise for a delightful piece of bookmaking.

HE MADE THEM TWAIN, A SOCIOLOGIST'S VIEWS ON MARRIAGE AND COMPANIONISM. By Bird S. Coler, LL.D. N. Y., Educational Press, 1931, 176 pp.

A distinctly modern book which is particularly refreshing in that it recognizes that all of our old institutions need not be thrown into the discard to insure the progress of civilization. Monogamous marriage according to Coler has stood the test of time and proved itself better than any substitute yet offered. Maintaining with incontrovertible logic that property rights are a basic necessity in the present-day scheme of things, he points to the necessity of the family unit as the keystone of such a structure and shows that the principles of monogamy are fundamental to the establishment of family responsibilities. Instead of making it easier to undermine and throw over these responsibilities the author advocates making marriage as it has come down through the ages a still more desirable and pleasant institution rather than to attempt to find a substitute for it as has been done by the radical school of modern sociologists, who, under euphonious terms, are in reality advocating and making attractive a return to early promiscuity and concubinage. Truly Mr. Coler's book is a wholesome and common-sense reminder that old fashioned decency have not yet been, and need not be, replaced by unbounded sexuality and licentiousness.

SIMPLE LESSONS IN HUMAN ANATOMY. By B. C. H. Harvey, M.D. Chicago, American Med. Assoc., 1931, 434 pp.

This is a narrative story of the anatomy of the human body so written as to be both interesting and instructive to the layman. Stripped of scientific verbiage the book is thoroughly accurate and scientific, and is just the book to place in the hands of those who wish to know something of the subject without desiring to master even the medical student's handbook. As Dr. Fishbein points out in the Preface: "Dr. Harvey has made the subject live," and many a layman will learn from this book that there is indeed more to the study of Anatomy than merely the dissection of the bodies of the dead, which is the usual concep-

tion of the subject. Here, at last, is a book that every physician may freely recommend to the patient who wants to know more about the structure and functions of his body.

FEMALE SEX HORMONOLOGY. By William P. Graves, A.B., M.D. Phila., W. B. Saunders & Co., 1931.

For a better understanding of the factors playing the major parts in the fundamentals of those disorders peculiar to women we urge a consideration of William P. Graves' monograph.

Since the beginning of the century such giant strides have been made in relation to the factors of the internal secretions that it comes as a refreshing relief to pick up a work minus all padding and lopsided half-baked theory. It is a comprehensive review of the advances in the knowledge of female sex physiology and the rôle played by the ovaries.

The work is the result of a building-up of the notes used by the author in his classroom work. Feeling others might profit by reading them, as it is necessary to search through a scattered literature to get all known facts in one scientific corral, he has offered them in book form.

The chapters consider: Early History (Proof that the Ovary is a Gland of Internal Secretion); The Sexual Cycle in Animals: Sex Cycles in the Ovary (Ovulation, the Corpus Luteum); Sex Cycles of the Human Uterus and Its Correlation with That of the Ovary; The Search for the Hormones of the Ovary; The Discovery of the Hypophysis as an Agent in the Sexual

and Reproductive Cycles (Pregnancy Test); The Hormones of the Anterior Lobe of the Hypophysis Identified; New Theories regarding Menstruation; New Theories regarding Parturition; New Theories regarding Lactation; Organotherapy (Amenorrhea, Dysfunctional Bleeding, Nervous Disturbances Related to the Menstrual Cycle). There is an interesting Glossary. The Bibliography offered is sufficient for the student if he desires to delve deeper into the subject. There is an index.

A well written, authoritative, up-to-the-minute, worthwhile work.

GYNECOLOGY AND UROLOGY FOR NURSES. By Samuel S. Rosenfeld, M.D. N. Y., William Wood & Co., 1931.

The author states in a preface that he has above all attempted to emphasize what the nurse most needs to know in order to be able to attend to her patients intelligently. In this the author succeeds admirably. He does not try to make a doctor out of the nurse, which, in these days, is a relief. Many intelligent physicians who have nursing and the teaching of nurses as one of their interests, complain that the undergraduate nurse is taught too much needless scientific hocus-pocus. Many who write books for nurses in their final effort give the impression they have thrown the book together in a haphazard manner. These faults are absent in Doctor Rosenfeld's small volume. And for this reason, not to mention that he has done his work with credit, we would recommend it to all pupil nurses.



BOOKS RECEIVED

All books received by THE AMERICAN JOURNAL OF SURGERY are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgment. Books that the Editor considers of special interest to our readers will be reviewed in a later issue.

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PERIPHERAL NERVE INJURIES

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THIRD INSTALLMENT

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CHAPTER VIII

EXAMINATION (*Continued*)

VIII. VASOMOTOR, TROPHIC AND SECRETORY DISTURBANCES

Numerous disturbances and changes of the nails, hair, joints and secretions in the vasomotor reactions and nutrition of the skin have been described as the result of peripheral nerve lesions. Considerable doubt exists as to the true nature of some of these disturbances. Some, perhaps, result directly from a lack of nerve supply but many are caused by other factors, such as injury to vessels or continued immobilization. The pathogenesis of these disorders is too controversial to permit of a definite opinion, and it is necessary only to point out their occurrence and in some instances to stress the conditions associated with their several appearances.

True vasomotor reaction disturbances may be demonstrated in the area of skin supplied by an injured nerve by recording the reactions to irritating substances, such as mustard oil, on the normal as compared to the injured side. On the normal skin, hyperemia with swelling and burning occurs; on the injured side there is no effect. Similar information may be obtained by the study of reactive hyperemia following freezing and stroking.

Disturbances in circulation are characterized chiefly by cyanosis, swelling, edema, hyperemia, local asphyxial attacks and gangrene. The cyanosis is accompanied by hypothermia and subjective coldness. It is increased by a dependent position of the extremity. The disturbance is not limited to the sensory distribution of the injured nerve but involves the whole affected extremity. The color varies from a reddish-purple tint to bluish-black. Often the area is succulent and when pricked with a pin blood gushes out. Such severe circulatory disturbances are rightly attributed by Bénisty and H. Meige to concomitant vascular lesions. Injury to certain nerves, for example the median, produces circulatory disturbances more than others.

Simons found that when the median and ulnar nerves were cut and the radial was intact vasomotor reactions were absent on the affected side, whereas with the radial alone involved no

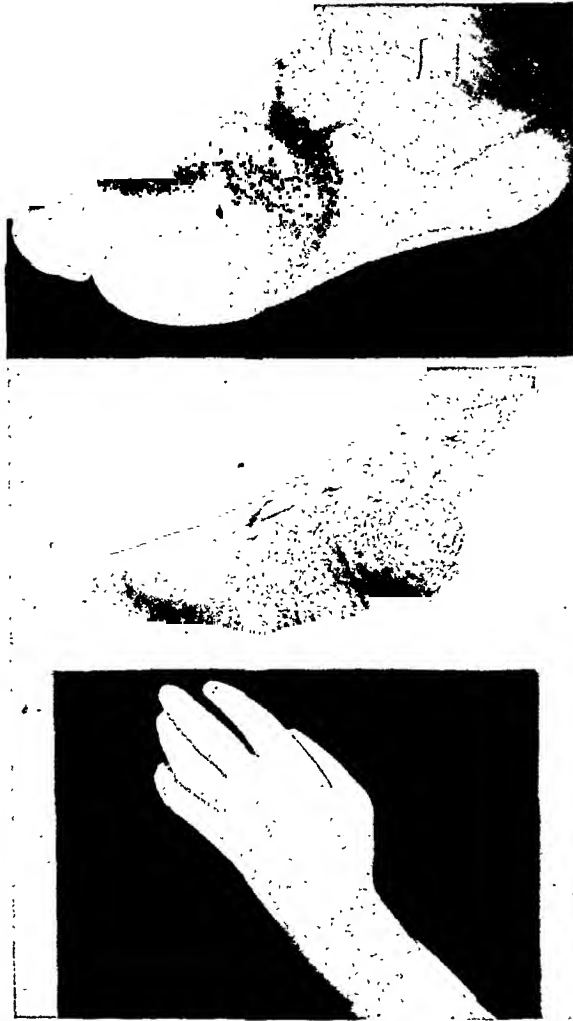


FIG. 55. Trophic and vasomotor changes in skin after peripheral nerve injuries.

change occurred in the vascular reactions. Vasoconstrictor spasms are rare. (Fig. 55.)

In addition to the glossy skin already described under the chapter on Causalgia, Weir Mitchell noted the occurrence of

thickening and drying of the skin and failure of desquamation. Head has pointed out that failure of desquamation is commonly noted over the sensory supply of an injured nerve, even when a

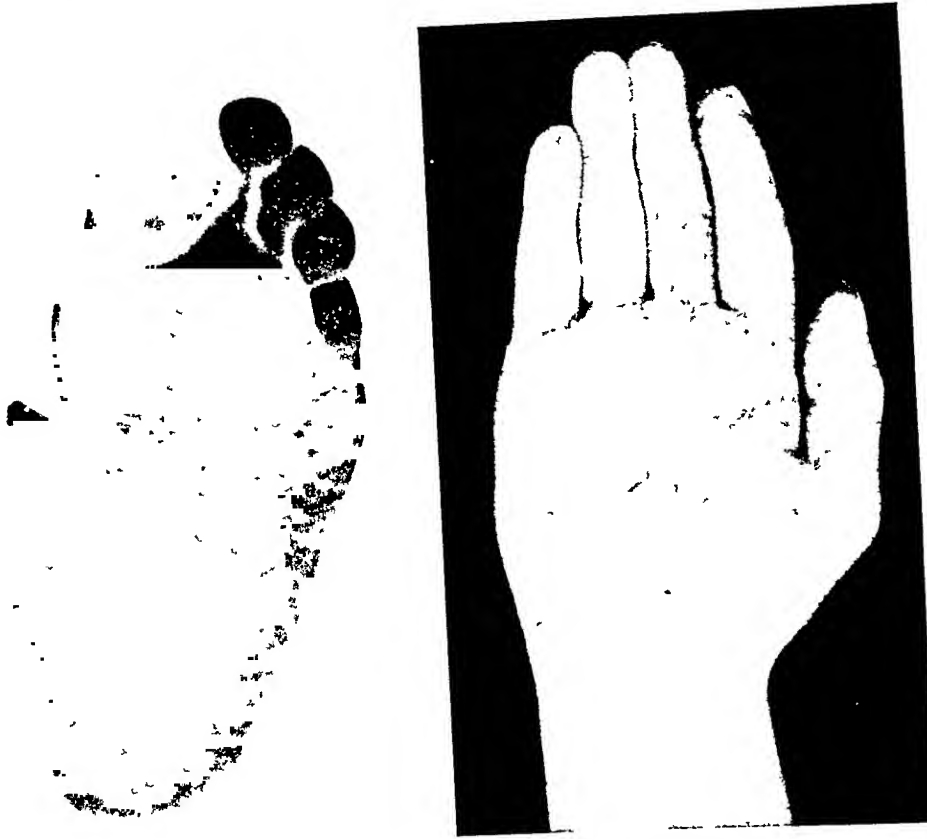


FIG. 56. Vesicular eruptions and keratoses which follow peripheral nerve lesions.

superficial sensory nerve alone is severed. The skin becomes inelastic and the cracks are better marked, giving the surface the appearance of the skin of a toad. This dry, rough and scaly skin is a frequent accompaniment of peripheral nerve lesions, whereas the glossy skin is relatively rare.

Athanasio Bénisty is of the opinion that Weir Mitchell included in his cases of causalgia cases of glossy skin with pain due to vascular lesions. She states that glossy skin is relatively rare in pure painful lesions of the median and tibial nerves. We have described the appearance of glossy skin in the chapter

on Causalgia and referred to the fact that in our material glossy skin without pain occurred chiefly in lesions of the median and tibial nerves, just as did causalgia. We did not



FIG. 57. Hypertrichosis following peripheral nerve injury.

observe many cases of vascular lesions in this group. Of 30 cases of injury to arteries which necessitated ligation and were complicated by nerve injury, no cases of glossy skin appeared. We are inclined to believe that glossy skin and causalgia, alone or combined, are due to the same factor and result from injuries of the median and tibial nerves.

As an accompaniment of glossy skin Weir Mitchell noted the occurrence of "eczematous eruptions" which appeared as minute vesicles thickly scattered over the thin and tender cutis, or else occurred in successive crops of larger vesicles on the skin about the altered parts. Similar eruptions are observed rarely in the absence of causalgia and glossy skin. Keratoses occasionally appear on the palm and sole, in median and sciatic nerve lesions respectively (Fig. 56).

Changes in the distribution and rate of growth of the hair are common. Loss of hair is seen commonly in cases of glossy

skin and causalgia. At times it occurs in other lesions. Hypertrichosis is common and the hair is long and fine. The hair changes do not follow the distribution of the injured nerve and



FIG. 58. Changes in nails following peripheral nerve injury.

are probably due to factors other than nerve injury. (Fig. 57.)

A decreased rate of growth of the nails is, as pointed out by Head, due to immobility. Overgrowth is common in painful lesions and the nail increases in the long axis to become protuberant over a clubbed finger. Extreme lateral arching occurs and the bed is adherent to the nail so that the space between the nail and finger is destroyed. Transverse ridges, irregular hypertrophy and discoloration may appear. The nail is often pink in color, brittle and horny. At times ulcers appear at its base. Thickening of the nail pad is common. Whereas some of these changes are due to immobilization, some are the result of concomitant vascular lesions. (Fig. 58.)

During the time when the skin is insensitive to pain it is particularly liable to injury. So-called trophic ulcers occur only

during this period and occupy the insensitive area. They are produced usually by some injury, such as burning the finger with a match when a median nerve injury is present. Flicking



FIG. 59. Ulceration of index and little fingers in median and ulnar nerve lesions.

cigarette ashes with the little finger in ulnar nerve lesions or rubbing the heel with an ill-fitting shoe in sciatic nerve lesions are frequent etiologic factors. Relatively low temperatures may produce blisters when the skin is hypothermic. At times

they occur without known cause, appearing first as a blood blister. Healing is very slow because of repeated injury and the existent vasomotor changes, but otherwise the process of



FIG. 60. Ulceration of heel and sole in sciatic nerve lesions.

healing resembles similar pathology in normal tissues. Infections are common and the ulcer burrows under the subcuticular tissues and at times affects the bony structures. Suppuration may occur, and a chronic sinus forms which continues to discharge a foul secretion. These ulcerations differ materially from those seen in vascular lesions where areas in which sensation is preserved are involved and massive ulceration and gangrene occur (Figs. 59, 60).

The changes in the subcutaneous tissues, such as edema, or subdermical, hard, inelastic induration, similar to chronic trophedema, are attributed rightly by Bénisty to vascular, or perhaps perivascular, lymphatic changes. Similarly, vascular lesions may produce fibrous degeneration or fibrosclerotic

changes in the flexor muscles of the fingers with retraction of their tendons. An appearance similar to Volkmann's contracture results.

Disturbances in secretion of sweat are commonly observed. Usually in complete lesions absence of sweat occurs and injections of pilocarpin fail to induce perspiration over the affected skin. Hyperhidrosis is common, particularly in partial lesions and at times in painful ones. Peculiar disturbances in the character of the sweat with putrid or sour odors occur infrequently. At times unpleasant odors may result from a maceration of the skin in painful lesions.

CHAPTER IX

EXAMINATION (*Continued*)

IX. ELECTRICAL EXAMINATION

The early hopes of neurologists and surgeons that a rapid electrical examination would serve to indicate the situation, nature and extent of a peripheral nerve lesion were quickly dissipated. Cases were found in which complete section of a nerve produced the electrical signs of a partial lesion, and indications of complete section were found in cases which presented a slight injury to the nerve. For a time electric diagnosis was discredited and later more carefully studied. As a result, it may be said that although alone it is not of absolute value, together with other signs and symptoms it is of certain diagnostic and prognostic assistance.

REACTION OF DEGENERATION: Normal nerves and muscles with an intact nerve supply react by constant, characteristic contractions of the muscles when stimulated by faradic and galvanic currents. When a nerve or muscle is stimulated by a single stimulus, make or break, there is produced a sudden rapid contraction which spreads so rapidly that to all intents and purposes a whole muscle contracts, and as quickly relaxes. If, however, the stimuli follow one another at regular and, to a certain degree, rapid intervals, as with the faradic current, a tetanic contraction of the muscle occurs. When stimulated by a constant current certain electric changes are produced in a nerve which differ with the intensity of the current, the polarity of the active electrode and the make or break type of stimulation. As a result, a law of the normal contraction in man may be formulated. The reactions of muscles follow closely those of a nerve. This law may be expressed by the formula: Kathodal Closure Contracture (KCC) > Anodal Closure Contracture (ACC) > Anodal Opening Contracture (AOC) > Kathodal Opening Contracture (KOC). (KCC > ACC > AOC > KOC).

A muscle is stimulated most readily through its nerve supply and contraction will be produced most readily when the stimulus is applied over the point of entry of a nerve, that is, over the motor point of the muscle.

When a nerve has been severed certain changes occur in reaction to electrical stimulation which, grouped together, constitute the "reaction of degeneration" (D.R.). These changes may be described as quantitative, qualitative, modal and polar.

The excitability of the nerve for faradic and galvanic current is abolished. The muscle loses its excitability for the faradic current (qualitative). In the early stages, for about the first two weeks, the muscle is hyperexcitable to galvanism, and later hypoexcitability gradually supervenes so that much greater quantities of current are necessary to produce a contraction (quantitative). The character of the response is entirely altered. The muscle having lost its fibrillary element, which contracts with a brisk twitch, and which can be stimulated by a faradic shock, now retains only its sarcoplasm, which contracts slowly and can be stimulated only by the galvanic current. The quick twitch is replaced by a slow contraction which spreads gradually along the fibers in a wave and the relaxation is similarly retarded (modal). Whereas normally the polar formula is $kcc > acc$ the degenerated muscle reacts in inverse order to galvanic stimulation, $acc > kcc$ (polar). In practice, polar inversion is not always present in a degenerated muscle and under certain conditions, such as chilling, may be found in normal muscles. It has been found that only the make stimulus of the kathode is effective and that the anode at its make is the indifferent pole. When a contraction occurs upon a make stimulus of the anode it is probably due to a stimulation by the virtual kathode at the point of exit on the opposite side of the muscle. Such virtual kathodes are not sufficiently under control to give reliable results, and polar inversion is inconstant and unreliable as a sign of reaction of degeneration. Failure of reaction of the muscle to faradism usually develops

after two weeks of progressive diminution. It has been found that in some instances when a proven complete anatomic lesion of the nerve has existed for a long time muscles supplied distally still respond to direct (not percutaneous) faradic stimulation.

The most valuable indication of the reaction of degeneration is the slow character of the muscle contraction. Unless graphically recorded by myograms, sluggishness of contraction requires some experience for its estimation, but commonly the appearances are unmistakable.

At times only a partial reaction of degeneration is found when the lesion is less severe. This often consists of only a diminution of faradic and galvanic excitability of the nerve or only a diminution of faradic excitability of the muscle and sluggish contraction or a rapid contraction and sluggish relaxation of muscle when stimulated by the galvanic current. Although evidence of a complete reaction of degeneration some months after injury may be accepted as indicating a severe nerve lesion, physiologic interruption cannot be differentiated from anatomic section by electrical examination. Complete reaction of degeneration cannot be used alone as an indication of an irreparable lesion. As time progresses in complete lesions the excitability of the muscle to galvanism diminishes and finally, from twelve to twenty-four months after the injury, completely disappears.

The reaction of degeneration is ushered in by an initial phase which is characterized by a progressive diminution of faradic excitability of the muscle, galvanic hyperexcitability of the muscle and a gradual increase of sluggishness of contraction of the muscle. This phase lasts from ten to fourteen days.

Whereas normally a muscle is most readily stimulated at its motor point, when degenerated the muscle responds to stimulation not through the medium of its nerve but directly through its fibers (Fig. 61). As a result, the muscle responds best to a current which passes longitudinally through its substance.

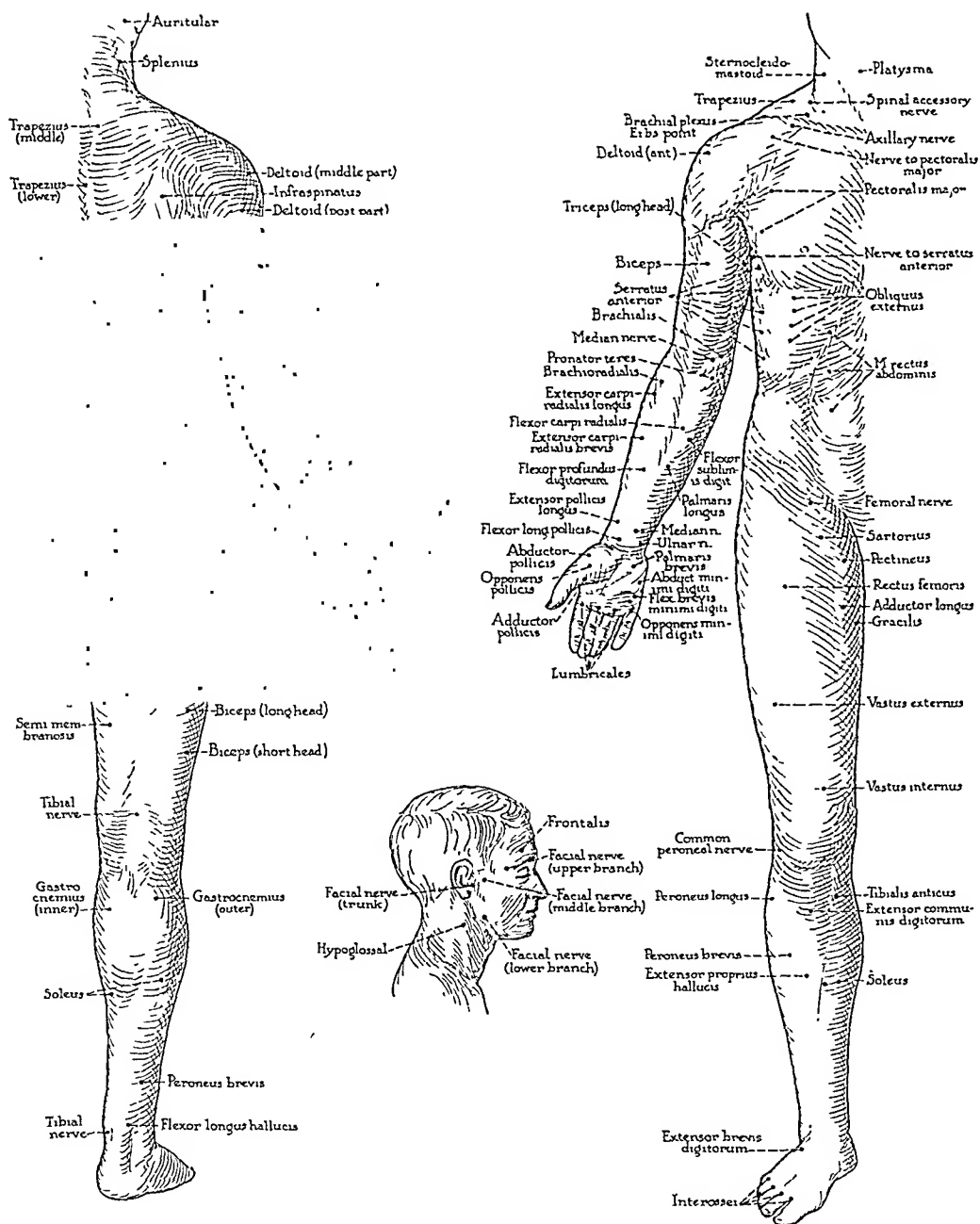


FIG. 61. Motor points for electrical examination.

This reaction, to which Ghilarducci gave the name of "reaction at a distance," is demonstrated by placing an indifferent electrode on the sternum or back of the neck and the active electrode not on the muscle itself but at a point *distal* to its tendon. The muscular contractions predominate at the closure of the negative pole and are elicited with currents three to four times weaker than those required to make the muscle contract with direct excitation. They are said to persist long after every trace of electrical excitability to direct stimulation has disappeared. Many clinicians place the active electrode on the lowest point of the muscle, near its tendon, and describe the reaction as the longitudinal reaction (Huet). Although the "reaction at a distance" is a constant and characteristic finding soon after injury, we have not found it to be of any value in lesions of more than six months' duration. The excitability has so diminished by this time that diffusion occurs into unparalyzed muscles when an attempt is made to produce a contraction by the use of increasingly larger amounts of current.

METHOD OF EXAMINATION: The apparatus necessary is found combined in many types of wall plates and tables. Faradic current may be obtained from an induction coil with two dry cells, and galvanic current from a battery of thirty-two elements which are capable of giving a current of 20 to 30 ma. (Fig. 62). When available, the most convenient source of electricity is that from an electric light current which furnishes direct current. When alternating current is used it must be converted into direct by a rectifier. A rheostat is necessary and a milliamperere meter should be in the circuit. The active electrode for galvanic stimulation should be a small, button-shaped one with a pad about 2 cm. thick. The handle should be equipped with an interrupter. The indifferent electrode should be large (7 × 7 cm.).

Examination with the faradic current may be conducted by the unipolar or bipolar method. In the unipolar method, the pads of the indifferent electrode, moistened with normal salt

solution, should be placed upon the sternum, lumbar region or opposite extremity. The active electrode which is also moistened is then employed in searching out and stimulating muscles

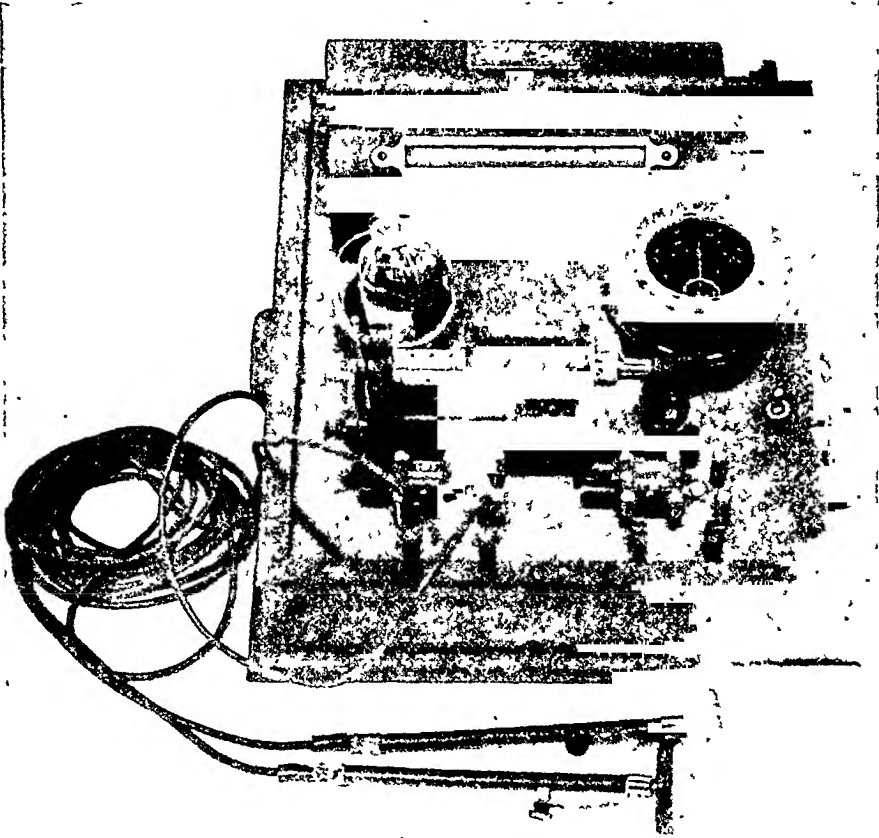


FIG. 62. Wall plate apparatus for making electrical examinations.

and nerves. It is usually found that such large amounts of current are necessary to produce contractions in paralyzed muscles that diffusion of current occurs into unparalyzed muscles and conceals any possible contraction of the affected ones. It is better, therefore, to use two small electrodes, both placed on the muscle to be investigated. This is the bipolar method. For examination with galvanism the unipolar method is usually satisfactory.

All the apparatus should be within easy reach of the examiner. The patient should lie or be seated in a good light, with the muscles perfectly relaxed. Contraction of muscles may be recognized from movement of the segments about joints, or by direct observation and palpation of the muscles when stimulated. If the movement of part of an extremity is to be used as an index of contraction, the part should be supported in that position which places the muscle in its most effective position. For example, in testing the extensor communis digitorum the proximal phalanges should be extended passively to the level of the dorsum of the hand. In testing the dorsal interossei the palm should rest flatly upon a table. As a general rule the muscle should not be in a position of complete elongation but should be midway between its lengthened and shortened states. It must be remembered that when fibrosis, shortening and joint changes render conditions suitable for supplementary motility, contraction of the muscles which produce such trick movements voluntarily may produce them when stimulated electrically. For example, stimulation and the resulting contraction of the flexors of the fingers may produce an extension of the wrist in radial nerve lesions. The contraction of a muscle can more readily be felt when it is completely relaxed and unstretched. When the contractions of the muscles of the uninjured extremity are used as an index of comparison with those of the injured one care must be taken to insure a similar distance between the electrodes.

Repeated stimulation over an area of skin reduces the resistance and produces a stronger stimulation, and in using the faradic current one should have this in mind. In using galvanism the milliamperemeter gives a relative indication of the strength of the current.

Often contractions resulting from electrical stimulation may enable one to detect the earliest voluntary motion. The patient may be able to maintain a position produced by the contraction of muscles electrically stimulated for a short time

when he is unable voluntarily to produce that motion or to maintain such a position passively produced.

Electrical examination likewise is often valuable to differentiate loss of motion due to severed tendons from paralysis. In the former galvanic stimulation followed by a good contraction in the muscle fails to produce a movement of that segment to which the tendon is attached.

CHRONAXIE: An electric stimulus must reach a certain intensity before it will result in the contraction of a muscle. This minimal current, however, must be prolonged for a certain length of time to produce a response. At "infinite duration" there is a minimum strength below which no contractions occur (rheobasic voltage). As the duration is decreased the strength must be increased until a point is reached where, no matter how strong the current, no contractions follow. The minimal duration of current necessary to produce a contraction with twice the rheobasic voltage has been designated empirically as the chronaxie of the tissue. The chronaxie of a human muscle with an intact nerve supply has been found to be 0.00016, whereas that of one whose muscle has degenerated is about 0.01. It was hoped that measurements of the chronaxie would furnish accurate information of diagnostic and prognostic value in peripheral nerve injuries. Although they have served to give precise measurement of the functional value of nerves and muscles in physiology, because of the inaccessibility of accurate instruments and the unreliability of certain others, few data are available which permit of critical judgment of its clinical value. When measured by the condenser system of Lewis Jones, it has failed to impress the American investigators with its reliability. More accurate methods, such as the Lucas pendulum, Lapicque's chronaximeter, Strohl's *érgersimètre* and Sachs' and Malone's chronomyometer have appeared to give accurate information in their several investigator's hands. It is possible that they may lead to profitable clinical investigations in the future.

CHAPTER X

EXAMINATION (*Continued*)

• X. REFLEXES

In general, disturbances of reflexes are not significant in relation to the diagnosis and prognosis of peripheral nerve lesions, as they are in disease or injury of the central nervous system. Frequently, however, they are of considerable importance. Naturally, they are very useful in diagnosis and prognosis of lesions of the cauda equina.

The most important deep reflexes are the Achilles' jerk, the knee-jerk, the wrist-jerk or stylo-radial reflex, the ulnar pronator reflex, the biceps-jerk and the triceps-jerk.

The muscles of the extremity whose reflexes are being studied must be completely relaxed. When a tendon reflex is to be elicited that tendon must be stretched passively to a moderate degree. In examining for deep reflexes it is important to note not only their presence but differences in reaction and degree of stimulation necessary to elicit them as compared to the normal side. Often a slight reaction may be felt in the contraction of muscle insufficient to produce a visible movement of segments about a joint. Great care must be exercised to avoid confusing an idiomuscular contraction with a true deep reflex. An idiomuscular contraction is obtained by striking the mass of muscle itself, preferably at its motor point. Frequently, during the early stage of reaction of degeneration, this reaction is increased and persists for a long time after a peripheral nerve injury. Ankylosis of joints and shortening, infiltration and fibrosis of muscles and fasciae frequently mask a deep reflex. Their presence should always be noted and properly evaluated in relation to the examination.

The Achilles' jerk is mediated through a reflex arc which is represented by the first and second sacral segments. It may be elicited by striking the tendon, which has been placed on tension by passive dorsal flexion of the foot, while the patient lies

in bed with the thigh and leg semiflexed, outwardly rotated and relaxed. It may be elicited more advantageously by striking the tendon similarly stretched with the patient kneeling on a chair and resting firmly upon the tibiae, with the muscles relaxed completely.

The knee-jerk, whose reflex arc is mediated through the third and fourth lumbar segments, is commonly obtained by striking the passively stretched patellar tendon. It is preferable to examine the patient in a recumbent position, the thigh and leg being semiflexed, outwardly rotated, and supported by one of the examiner's hands. Likewise the reflex may be elicited by pressing the patellar tendon downward with a forefinger, putting the quadriceps muscle upon a stretch and then striking the finger with a percussion hammer. Less satisfactory methods are to strike the patellar tendon with the patient sitting in a chair with the feet resting upon the floor, or with the leg to be examined crossed over the opposite one. At times complete relaxation is difficult to obtain and some method of "reinforcement" may be used. The patient, looking upward, may lock the hands together, pulling them one against the other, upon the count of three when the examiner strikes the tendon with the hammer. Or, the examiner may grasp the quadriceps of the patient who sits in a chair with his soles flat upon the floor. The patient then grasps the arm of the examiner and squeezes it firmly when commanded, at which moment the examiner strikes the tendon.

The stylo-radial reflex, or wrist-jerk, mediated through the fifth and sixth cervical segments is elicited by striking the stylo-radial process. The forearm should be semiflexed and midway between pronation and supination, with the muscles all relaxed. This reflex evokes a contraction of the biceps, the brachialis anticus, the supinator longus and, at times, some fibers of the deltoid.

The ulnar-pronator reflex, innervated by the seventh cervical segment, is evoked by striking the posterior surface of the styloid process of the ulna, the upper extremity being in a

position similar to that just described. It produces a movement of pronation of the wrist.

The triceps-jerk, mediated through the seventh and eighth cervical segments, is elicited best by supporting the upper extremity with the arm horizontal and the forearm semiflexed, the muscles being completely relaxed. Then after locating it by palpation the triceps tendon is struck with the hammer. This produces a contraction of the triceps and an extension of the forearm.

The biceps-jerk is represented in the fifth and sixth cervical segments. It is elicited by striking the bicipital tendon through the examiner's finger or a pleximeter placed over the tendon with the upper extremity supported and the forearm semi-extended.

Cutaneous reflexes are affected chiefly by lesions of the cauda equina and of the nerves of the lower extremities. The plantar reflex is evoked by stroking the outer edge of the sole from the heel to the toes. At times it may be obtained better by stroking the middle or inner side. Normally, plantar flexion of all the toes results. The cremasteric reflex is affected most frequently in injuries of the spine which produce cauda equina lesions, and injury to the adjacent emerging roots. The cremasteric reflex is obtained by stroking or compressing the inner aspect of the thigh. Care must be exercised to differentiate the slow, vermicular contraction of the dartos muscle from a real reflex, which produces a sharp retraction of the testicles toward the inguinal canals. The abdominal reflexes, upper and lower, consist of a brisk contraction of the muscles when the skin over the abdominal wall is stroked from behind forward. At times the gluteal reflex is absent in high lesions of the sciatic nerve. This consists of a contraction of the glutei when the skin over the buttocks is stroked.

CHAPTER XI

DIAGNOSIS

DIFFERENTIAL DIAGNOSIS

The diagnosis of complete lesions of peripheral nerves is essentially simple. Other causes of loss of motor function such as severed tendons, fractures, dislocations, inflammatory reactions, fibrosis and ischemic paralysis are differentiated readily by the absence of the combination of motor and sensory loss and change in electrical excitability. The electrical reaction is particularly valuable in the differentiation of severed or adherent tendons. When the injury is distal to the point of the exit of a nerve branch to that particular muscle the diagnosis is self-evident and is further confirmed by the contraction of the muscle upon faradic stimulation, without appropriate movement of the segment normally moved by that muscle. When the injury is above or at the level, stimulation below the lesion will produce movement of the segment and stimulation above the lesion will produce contraction of the muscle and no movement of the segment.

At times when an injury produces, among other things, a loss of function of a particular nerve, other changes such as hemorrhage, fracture, edema or inflammation may produce signs and symptoms which may be misinterpreted as an injury to an additional nerve. These signs and symptoms never produce the complete syndrome of a nerve injury and are fleeting in nature.

In general, when a particular peripheral nerve is severely injured there is a paralysis of a particular group of muscles, a loss of sensation over a certain constant area of skin and an inability to perform specific movements. In partial lesions of some nerves, such as the radial, there may be little or no sensory loss and a dissociated paralysis may lead to some difficulty in diagnosis. Electrical examination then is of great service and

when evidence of the reaction of degeneration is found a diagnosis of a peripheral nerve lesion is evident.

Injuries of the central nervous system usually afford little difficulty in differential diagnosis. In lesions of the corticospinal tract the signs of an upper motor neuron injury rapidly determine the diagnosis. These signs are spastic paralysis, increased deep reflexes, diminished superficial reflexes, presence of pathologic reflexes, such as the Babinski phenomenon and absence of marked atrophy, or the reaction of degeneration.

Unilateral lesions of the spinal cord, with concomitant brachial plexus injury, at times present a picture, when seen some time after injury, which leads to failure of recognition of the brachial plexus lesion. In such cases the paralysis of the upper extremity may be attributed wrongly to injury of the anterior roots or anterior horn cells. Usually the absence of a segmental character of the loss of motion and sensation points to the correct diagnosis. This will be dealt with further in the chapter on the Brachial Plexus.

Intramedullary spinal cord lesions, although rare, are differentiated by the segmental distribution of paralysis and the dissociated sensory loss. For example, there may be a loss of heat, cold and pain sense and preservation of touch.

Lesions of the cauda equina, when unilateral, may offer some difficulty. Disturbance of rectal and bladder reflexes, and sensory loss in the saddle area, which involves the third, fourth and fifth sacral segments, serve to localize the lesion accurately.

An organic lesion is characterized by the production of certain constant and expected signs and symptoms, and only those. A paralysis of functional nature such as that found in hysteria, is characterized by some signs and symptoms which could not be the result of a lesion which produces other signs and symptoms. In addition certain signs and symptoms which would inevitably result from such a lesion are usually absent.

The disturbances of motility in a functional paralysis are characterized by their variability. The patient may profess to

be unable to extend the hand upon command and yet be observed to extend it to a slight degree in performing some other required function. Or, although no contraction in the extensors may occur upon request, in the course of the examination the hand may be passively extended and remain in that position. The deformity which is present never follows the physical laws of loss of function of particular muscles. Often a contraction may be found in the supposedly paralyzed muscles. Thus in a supposed inability to extend the wrist or contract the extensors, the hand may be held fixed in a position of semi-extension, although the wrist may be passively moved freely in all directions. The position of extension will then vary in degree according to the position in which it is passively placed, or it may again assume such a position after the hand is passively flexed. The position produced by the contraction or deformity cannot be explained by the paralysis of any group of muscles supplied by one or more peripheral nerves, neither can it be explained by the unopposed action of other groups of muscles supplied by other specific nerves. Thus in a supposed inability to move any muscle of the lower extremity, the leg, foot and toes may be held rigidly in extension. Or, in the case of an inability to move the fingers, the fingers may be flexed at the proximal and extended at the distal phalanges. The loss of function includes certain muscles which could not be affected when only a certain nerve was injured. On the other hand, there is movement of other muscles which would be paralyzed if such a nerve were actually injured. Thus, in an inability to flex the wrist or any of the fingers the thumb may be opposed to the little finger (median) and a piece of paper may be grasped tightly between the thumb and index finger (ulnar). Manifestly this is a combination which could not occur as the result of a combined ulnar and median nerve palsy which would appear to be present in view of the loss of motion in the wrist and fingers.

When sensation is lost in a functional lesion the area of anesthesia never follows a peripheral or even segmental dis-

tribution. It is more often geometric in distribution such as glove and stocking anesthesia on the volar or dorsal surfaces. However, when muscles supplying flexion are supposedly paralyzed as in a combined median and ulnar nerve lesion, and the entire palm is anesthetic, the dorsal surface of the distal phalanges of the index and middle fingers may have quite normal sensation. Moreover, the borders of the area of sensory loss constantly shift during examinations conducted only a few minutes apart. When a patient complains of spontaneous pain and tenderness on pressure, examination for tactile sensation may develop an anesthesia, then an analgesia and finally pressure of considerable force may be exerted without evoking sensation. Often the patient may be instructed to say "yes" immediately when he feels a pin prick and "no" when he does not feel it. Under such a condition the patient may reply "no" with absolute chronological accuracy when the stimulus is applied to a professedly completely anesthetic and analgesic zone. The borders of the areas to tenderness or pressure shift with each rapidly succeeding examination. This is well demonstrated by making simultaneous pressure with two fingers, one over the point of supposed tenderness and the other a short distance away. No areas of overlap are found, and usually sensation of all modalities is lost over the same areas. Peculiar dissociations of sensory loss may at times be found. Thus, a patient may profess to be unable to feel pain but to distinguish heat and cold.

Reactions of the muscles to faradism and galvanism in a functional paralysis are always normal except when the extremity shows vasomotor change. Then a quantitative diminution may be present. The reaction of degeneration is never present. Trophic ulcers are not found, although cyanosis and hyperhidrosis of the palm and an apparent increased nail growth are common. When muscle atrophy is present it is general in character and does not select certain muscles.

The occurrence of functional paralysis, spasms and contractures varied in different armies in the war to an astounding

degree. Cases which simulated lesions of the peripheral nerves were exceedingly rare in our material, which was gathered from four large base hospitals in France (Base Hospitals 24, 28, 13 and 3), and a general hospital (U. S. General Hospital 28) in the United States. A considerable number of cases of "barracks back" (camptocormia), astasia abasia, hysterical paraplegia and hemiplegia, mutism, aphonia, myoclonias, stuttering and tremors were seen, but so few cases of involvement of only one extremity came to our attention as to be notable.

Paralysis limited to one anatomical region or group of muscles with wounds at a distance was seen commonly among the French forces. It is exceedingly likely that the relatively short duration of time our troops participated in the war, the rapid movement from one to another hospital, the frequently required redressing and inspection of wounds and the prevention of prolonged uninterrupted immobilization and monotonous hospitalization were factors in the prevention of the development of these functional disabilities.

Not only were well-recognized examples of hysterical paralysis and contracture of upper and lower extremities found by the allies, but many of the French observers separated from the total material a group which Babinski and Froment designated as reflex nervous disturbances, and later as physio-pathic affections. These contractures or paretic conditions which occur at a distance from a wound have this common characteristic; they are sharply localized in a segment of a limb or in certain muscular groups, commonly of the extremities. Though the tendon and bone reflexes may not be modified to any extent, there is generally a condition of mechanical hyperexcitability of the muscles of the affected limb, and a corresponding hyperexcitability to faradic and galvanic currents, with rapid fusion of the contractions. These modifications of excitability are partly the result of the lowered temperature of the extremity. They improve upon the application of heat and are exaggerated by cold. The contractures disappear under ether anesthesia, but at times only under deep narcosis.

Vasomotor disturbances are very frequent. A hand may show cyanosis, lowered temperature, diminished amplitude of the pulse, disturbances of sweat secretion, moisture, maceration of



FIG. 63. Contracture of fingers without injury to peripheral nerves of upper extremity. This is an example of the congealed hand (Meige) or a physiopathic affection (Babinski and Froment).

skin and decalcification of bone. This condition, also termed the congealed hand of Meige, acromyotonia by Sicard and paratonic paresis of Marie and Foix, resists all physiotherapeutic methods which ordinarily improve rigidities and contractures which result from osteo-articular and muscular lesions. Psychotherapy, in the hands of many, has proved equally ineffective. (Fig. 63.)

The pathogenesis of these affections has been very extensively discussed. Babinski and Froment, Léri, Roger and Guillain and A. Barré were the first to insist upon the necessity of distinguishing these disorders from hysteria. Babinski and Froment regard the lesion as being of a reflex character. By some the condition is regarded as due in some cases to irritation of the muscle by metal dust; in other cases, to irritation of a nerve by foreign bodies, or cicatricial fibrous tissue. By others it is thought to be the result of ischemic contraction or neuritis. Many attribute it chiefly to prolonged immobilization of the extremity. On the other hand, as has been pointed out by Claude and Lhermitte, and Roussy and Lhermitte, all the signs described by Babinski and Froment as characteristic

of reflex disorders may be found without any bodily wound, and at times they disappear under treatment by psychotherapy. It is sufficient for our purpose to note the occurrence of these disorders and to indicate the source of information concerning them in the event the necessity arises for their recognition, study and treatment.

CHAPTER XII

DIAGNOSIS (*Continued*)

I. SIGNS OF SEVERE NERVE INJURY

If it were possible to differentiate complete interruption of the function of a nerve due to section from that due to contusion or compression, an immediate decision could be reached for early surgical intervention. This would result in a marked increase of the recovery of function of injured nerves. However, in many instances this conclusion can be reached only after a period of observation of a number of months.

Many attempts have been made to discover a sign or a group of signs which would justify a rapid differential diagnosis between a complete anatomic section of a nerve and one in which complete loss of function is the result of a physiological interruption of the nerve fibers. Similarly, attempts have been made to differentiate those cases which have a complete loss of function and which are spontaneously recoverable from those which will not recover without surgical interference.

Some observers have thought it possible to distinguish several definite symptom-complexes. Thus, Mme. Dejerine and J. Mouzon have described the syndromes of interruption, of compression, of irritation, of dissociation and of recovery, each of which has a distinctive group of signs and symptoms. The syndrome of interruption, or anatomic section, is characterized by (1) complete paralysis of all muscles supplied by the nerve below the lesion; (2) complete absence of tonicity, as demonstrated by softness and flaccidity of the muscles, and by the position of the extremity at rest. For example, the wrist-drop of a radial nerve lesion, the ape hand (median), the irreducible claw hand (ulnar), the excessive varus equinus (peroneal), and the foot-drop of a sciatic nerve lesion are all characteristic deformities. Finally, they call attention to the absence of pain on pressure of the muscles supplied by the injured nerve. Of secondary importance are the abolition

of reflexes, exaggerated excitability of the muscle to mechanical stimulus, amyotrophy, certain other deformities such as dorsal swelling of the carpus or tarsus, complete reaction of degeneration in the paralyzed muscles, absence of any zone of hyperesthesia or paresthesia in the region supplied by the injured nerve, absence of pain on pressure applied to the nerve trunk below the lesion, and the topographic distribution of the changes in objective sensibility.

The syndrome of irritation as described by these authors includes the painful injuries of nerves whereas the syndrome of dissociation relates to partial nerve lesions which give rise to an incomplete paralysis.

Dejerine and Mouzon described the syndrome of compression as characterized by the same phenomena as those of interruption, but to a lesser degree. Of paramount importance is the presence of pain when the muscles and nerve trunks are subjected to pressure, and the lesser degree of impairment of objective sensibility. This latter consists generally of hyperesthesia. The syndrome of regeneration will be referred to in the chapter upon Nerve Regeneration.

If these syndromes had absolute diagnostic value the entire matter of surgical treatment would be simplified. Unfortunately, this is not the case and the artificial division of cases into these groups has not withstood the tests of critical investigation.

In accordance with Pitres and A. Bénisty, we feel that there is no way by which a complete loss of function due to anatomical interruption can be differentiated from the complete loss of function due to physiological interruption produced by compression. From a single examination, at a given time, we can determine only whether the loss of function is complete or incomplete. If it is complete we cannot tell whether or not it is due to anatomical interruption, nor can we predicate whether it will recover spontaneously or will require surgical treatment. Of course, if it is incomplete, anatomical division cannot be present except in the form of a lateral notch.

In a case of complete physiological interruption we may say that an anatomical section does not exist, only when a subsequent examination shows some return of function. No other sign or group of signs suffices. In general, the course of the clinical picture is much more important than any group of signs for the purpose of determining the severity of a lesion.

The various clinical signs which result from the complete interruption of a nerve have been given a different value and significance by different investigators. Each one has proposed a certain grouping of symptoms in the order of their supposed value and many have added certain signs of their own. The following signs are accepted in common by the majority: (1) complete paralysis of all muscles supplied by the nerve below the lesion; (2) complete reaction of degeneration; (3) rapid and extensive atrophy of the paralyzed muscles; (4) absence of pain on pressure applied to the nerve trunk below the lesion; (5) loss of objective sensibility in the supply of the affected nerve. Bénisty has included vasomotor and trophic disturbances, especially the decrease in the local temperature of the skin which covers the atrophic muscles. From our material, the following analysis, which assembles some of the material already described under separate heads, may be made:

Complete loss of all the functions of a nerve indicates a severe lesion and is interpreted as a complete physiological interruption of that nerve.

Total paralysis of all the muscles supplied by a nerve distal to a lesion cannot alone be used as an indication of the severity of that lesion. Particularly is this true of the radial nerve. Slight injuries of this nerve produce total paralysis.

Complete loss of sensation in the isolated supply of a nerve indicates and is interpreted as complete physiological interruption of sensation.

Only when sensation is present in the isolated supply of a nerve can the lesion be considered as a partial one. The area of the isolated supply to pin prick of various nerves is the area

in which no overlapping occurs and is described in the chapter on Nerve Overlap. The area of analgesia to pinching corresponds to the area of the isolated supply of a nerve to pin prick. In our opinion this is an excellent indication of a severe nerve lesion.

Regarding the electrical changes demonstrated by the methods personally employed, namely, faradic and galvanic stimulation, it may be said that the complete reaction of degeneration is always present in a severe lesion. However, it does not indicate an irreparable lesion. A progressive increase in the signs of the reaction of degeneration speaks for a lesion which will not recover spontaneously. Of all the changes to electrical stimulation the slowness of the muscular contraction was the only constant phenomenon which could be satisfactorily employed to determine the reaction of degeneration. Polar changes were inconstant. Of course, it may be expected that the response to faradism would be absent frequently, even in partial lesions. Especially is this true of cases which require more than four months for recovery. Although electrical examinations afforded no means whereby a differentiation between anatomical and physiological interruption could be made in the cases observed within a year following injury, it must be remembered that frequently after this period, and always after 100 weeks, irreparable lesions show complete loss of response to any form of electrical stimulation. The longitudinal reaction did not prove to be of any particular diagnostic value.

Rapid and extensive atrophy of the paralyzed muscles may be interpreted to mean a severe lesion, with a number of reservations. Regardless of their severity, ulnar nerve lesions as a rule show extensive atrophy. Atrophy is of service in denoting the severity of a lesion only when it is present soon after injury. The amount of atrophy observed some months after injury is not commensurate with the severity of the lesion, nor is absence of demonstrable atrophy an indication of a spontaneously reparable lesion.

Absence of pain when the trunk of the nerve is subjected to pressure below the seat of the lesion was demonstrable in many severe lesions, but quite a number of recoverable lesions showed this analgesia as well. On the other hand, not a few irrecoverable lesions showed the preservation of pain to such pressure. Only the ulnar, radial and peroneal nerves are suitable for isolated pressure upon their trunks and this only in such cases in which the injury is proximal to their superficial positions. The danger of producing pain by pressure upon adjacent structures is too great to make this a universally diagnostic phenomenon of certain value.

In agreement with Meige and Pitres, absence of any pain on pressure of the muscles which are paralyzed was found a very unreliable sign. In fact, it was found that in a large number of cases tenderness to pressure was more marked on the injured side. Probably it could be attributed in some cases to the injury of other tissues; in others, to supplementary supply of sensation to the paralyzed muscle by adjacent nerves.

We do not feel that the absence of hyperesthesia in the area supplied by an injured nerve is an indication of the severity of the lesion. As a matter of fact, it is not uncommon to find hyperesthesia in the presence of a completely interrupted nerve when sensation to pin prick has returned as the result of nerve overlap.

When tone was measured by a tonometer, it was found that only for a short time after an injury of a peripheral nerve was the loss of tone any indication of the severity of the lesion. Even then the loss of the tone represented only a reflection of the general loss of function. The difference in millimeters of mercury was expressed in the ratio of from 160 to 180 in normal muscle to 40 to 60 in the paralyzed ones. In a very few weeks, infiltration, fibrosis and other changes in the muscles and tendons vitiated whatever significance loss of tone might have.

Too little is known of the nature of trophic disturbances to enable us to employ them profitably in interpreting the severity of the lesion. When protopathic sensibility was lost trophic

ulcers were likely to occur. When an extremity was immobilized, the growth of nails ceased. When an extremity was protected by a dressing hypertrichosis was at times observed. Generalized atrophy of the bones indicated only disuse. In other words, the trophic disturbances can be employed as an indication of the severity of the nerve lesion only when they are associated with more important signs.

We consider that when they exist together the complete paralysis of all muscles supplied by a nerve below the level of the lesion, the complete loss of sensation over the accepted sensory distribution of the isolated supply of a nerve and the complete reaction of degeneration are the only reliable signs of a complete interruption of function of a peripheral nerve. Whether this interruption is due to anatomic section or not cannot be determined. Whether the lesion may recover spontaneously can be told only from the evidence of some return of function in motion, sensation or electrical excitability as may be determined by continued examinations over a period of time.

CHAPTER XIII

DIAGNOSIS (*Continued*)

II. RECOVERY OF FUNCTION

The signs of regeneration of a nerve are the manifestations of recovery of function. Among these are return of sensation, both subjective and objective, disappearance of the reaction of degeneration, return of motion, increase of tone and disappearance of muscle atrophy.

These manifestations differ in appearance and rate of return in relation to the pathology of the nerve and according to whether recovery is spontaneous or is consequent to surgical intervention. They are dependent upon the condition of the neuraxons. If descending degeneration has been slight or absent and the nerve recovers spontaneously and rapidly the clinical course of the symptoms of recovery of function may be quite different from that seen if resection and suture have been performed. If little or no degeneration has followed, but a complete physiological interruption has existed for a long time, perhaps because of a constricting band of scar tissue, surgical relief of this condition may be followed by symptoms of regeneration similar in character to those observed in lesions which rapidly recover spontaneously. If descending degeneration is severe or complete and conditions are such that the lesion recovers with no surgical interference, the course of recovery will be very similar to that observed which follows nerve suture.

Many cases of complete physiological interruption of a nerve showed their first sign of regeneration at such a time as one would expect it to occur were the nerve divided at the time of injury and sutured. From this time onward the signs of regeneration progressed exactly as they would in a sutured nerve. It is reasonable to assume that in this type of severe lesion complete descending degeneration had occurred and conditions permitted the regeneration of the axons. Evidence

of regeneration first appeared in from the eighth to ninth month, and it was noticeable that a considerable number of men wounded at about the same time all began to improve together.

The order in which the signs of regeneration appear has been given by Bénisty as follows: (1) sensory regeneration, consisting of pain when the skin is pinched, pain when the nerve is pressed below the lesion, formication on pressure of the nerve and spontaneous aching in certain muscles; (2) arrest of muscle atrophy and return of tonicity; (3) in some cases return of faradic contractility; (4) disappearance of objective sensory disturbances; and (5) return of voluntary movements.

RECOVERY OF SENSATION: Rapidly and spontaneously recovering lesions showed two characteristics. First, in agreement with others (Sherren), we found that such lesions do not show the dissociation of sensation to which reference has been made. In these cases little or no sensibility to pin prick returned before tactile sensation. Both forms of sensation are absent and return together. Second, the return of function did not adhere to any definite rate of progression, either as to sensation or motion, and often all the muscles innervated by a nerve regained their function suddenly, irrespective of their distance from the lesion. Painful sensation evoked by pinching the skin is one of the earliest manifestations of recovery, and considerable valuable information is obtained by this method, as has been pointed out by André-Thomas and Babinski.

From an examination of 150 records which showed loss of sensation to pinching we found that when a single nerve is severed and the area of skin which it supplies is surrounded by skin supplied by intact nerves, no loss of sensation to pinching is found. Usually no loss to pinching could be found in severe lesions of the peroneal nerve, or in severe lesions of the radial nerve. Nerves which supply the distal portions of the extremities, as the ulnar and median, when severed showed loss to pinching. In all complete lesions of the ulnar nerve loss to pinching occurred in the distal phalanges of the little finger.

Only in recovering lesions is there no loss to pinching, and partial loss is found in partial lesions. In severe lesions of the median nerve loss to pinching occurred in the index and middle fingers; in recovering and partial lesions loss to pinching may be observed in one or the other finger only. When this is true, sensibility to touch and pain is only partially destroyed. When no loss to pinching was found the lesion was partial and was recovering. In combined section of the ulnar and median nerves loss of sensation to pinching was found in the distal phalanges of the four fingers. One or another of the fingers showed preservation of sensation in partial lesions, and were accompanied by similar partial involvement of tactile and pain sensibilities. In section of the sciatic nerve loss of sensation to pinching was found in the isolated supply of this nerve to deep sensation. No loss to pinching occurred in recovering lesions. When the peroneal portion of this nerve alone was severely injured, some loss to pinching was observed in the sensory area of the peroneal nerve.

These observations would permit one to select severe lesions rapidly when it is necessary to examine a large number of cases hurriedly. However, the same precautions must be observed relative to examination by pinching as by other methods of stimulation. The return of this sensibility is valuable as a sign of recovery only when it returns in areas in which there is no overlap of adjacent intact nerves. Attention has been called to its appearance in small, circumscribed spots. From our observation, these spots which later combine occur chiefly in areas of overlap and are not due to regeneration. However, all observers feel that this sign precedes the appearance of formication noted by Létiévant and described by Tinel.

Formication of distal tingling on pressure (*Tinel's sign*) is described as a tingling or other paresthesia in the part supplied by a peripheral nerve when the site of the injury is percussed, and later when the nerve is percussed at progressive distances distal to the injury. It has been said to give valuable early

information as to the process of regeneration. As long as the formication is elicited only from the site of injury the sign is valueless because cicatricial topoparesthesia is a constant accompaniment of neuronal formation. When repeated and successive examinations, with palpation and pressure on the nerve distal to the injury, give rise to formication at increasing distances from the point of injury with certain precautions it is a possible indication that regeneration is occurring.

The reaction is commonly obtained first at the site of injury as early as the twentieth day, but generally between the fourth and sixth weeks. By the thirtieth day it may be obtained 2 cm. below the lesion; by the sixtieth, 5 cm. and upon the ninetieth, 9.5 cm. below the lesion. The rate of progression varies in different cases. MacDonald has pointed out that the downward progression occurs at a rate of 1-2 mm. a day, and that after the expiration of 100 days the site of injury is no longer irritable. At the expiration of another 100 days the irritable portion of the first period loses its irritability. It is suggested that the percussion be made from the periphery proximal because if formication is once produced it may persist for some time and lead to misinterpretations.

American observers have not been in general agreement as to its precise value. Our personal experience would lead us to discredit it as a reliable index of regeneration. If the sign is elicited by palpation alone some value may be attached to it. If it is elicited by percussion but little value can be ascribed to it since connective waves of motion are transmitted to the newly formed curling axons at the site of the neuroma. As an example of its unreliability, we failed to elicit it in 7 of 50 recovering cases. In 8 cases the formication could be elicited from a point only a short distance from the site of injury. The sign was elicited completely in 5 per cent of 50 complete interruptions and was absent entirely in only seven. The variance of technique and interpretation in the hands of a group of investigators makes it an unreliable clinical sign in the hands of a standard observer.

Frequently a spontaneous aching, and more frequently a "different feeling" in the sensory distribution of a nerve were early signs of sensory regeneration. Although many authors believe that pain produced by pressure upon a nerve distal to the point of injury has some prognostic significance, we did not find it so.

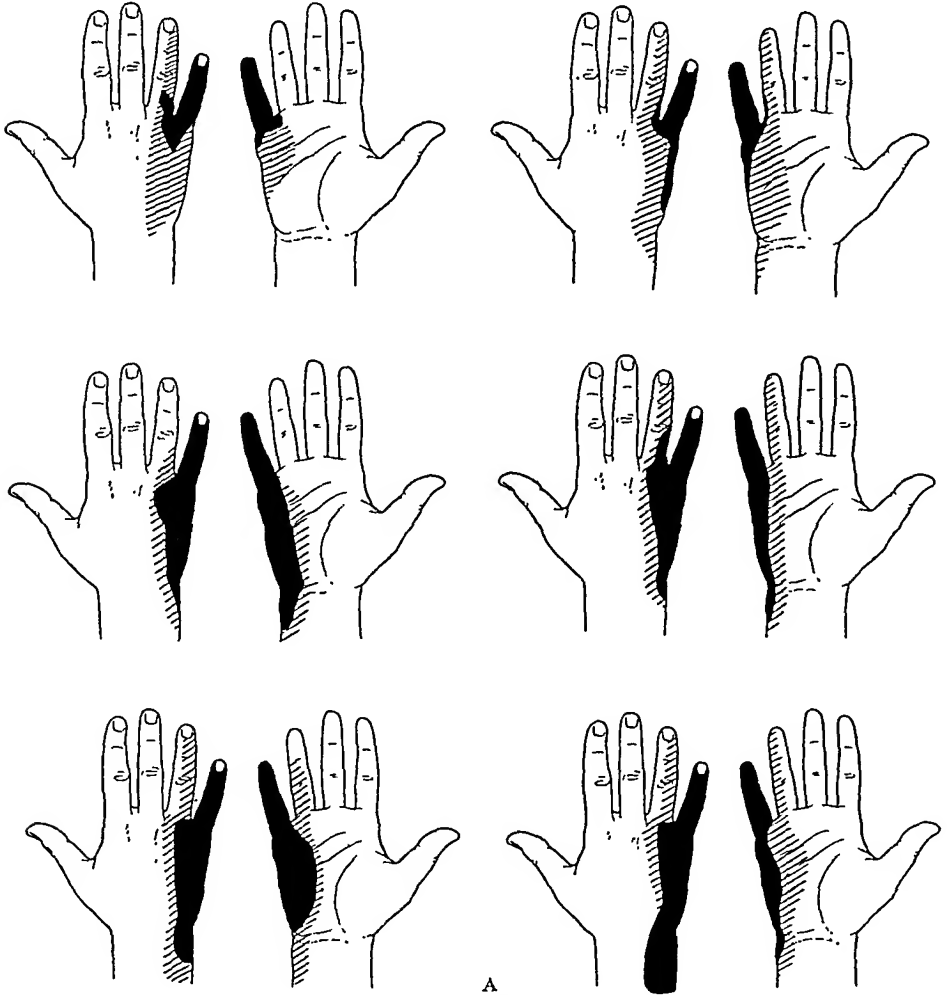
After the development of these early signs of regeneration sensation to objective stimulation returns, much as has been described by Head, although, as pointed out in the chapter on sensory Nerve Overlap, our interpretation of this return is materially different. We cannot emphasize too often that only when that portion of the area representing the anatomic sensory supply of an injured nerve which is removed from the influence of overlap, in other words *its isolated supply*, becomes sensitive can we say that regeneration is present. The recovery of sensation occurs in patches scattered over the previously anesthetic area and not only on its borders. It is notable that only once did sensation to pin prick and touch return in an area of isolated supply before there was a return of motor function.

PATTERN OF SENSORY RECOVERY IN PERIPHERAL NERVE LESIONS: A comparison of the sensory charts of complete lesions with those of recovering ones has brought out some interesting observations which merit description.

The return of sensibility to pain as the result of overlap in complete lesions follows a pattern so characteristic that it may be recognized at sight. For example, it never returns in the distal phalanges of the little finger in ulnar nerve lesions, nor in the distal phalanges of the index and middle fingers in median nerve lesions. It always occurs along the borders of an uninjured nerve and may well be described as a shrinkage (Fig. 64).

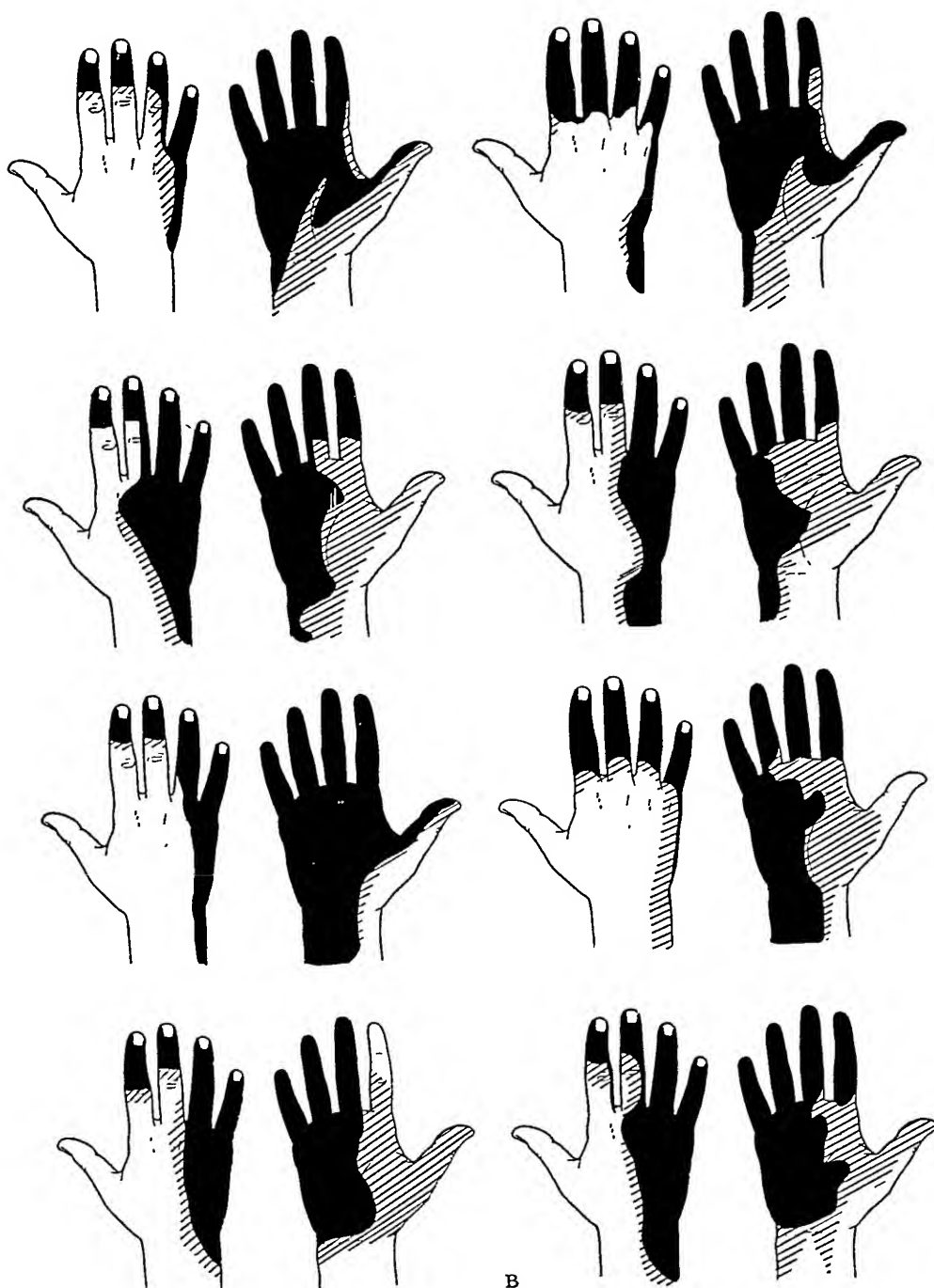
Contrasted with this, the pattern in recovering nerves is strikingly different. Although shrinkage occurs, other changes are always present. The material consisted of about 400 cases from which the general conclusions have been derived. From

this material there have been selected a number of cases which recovered after operation, and these were contrasted with those cases which recovered spontaneously. No difference



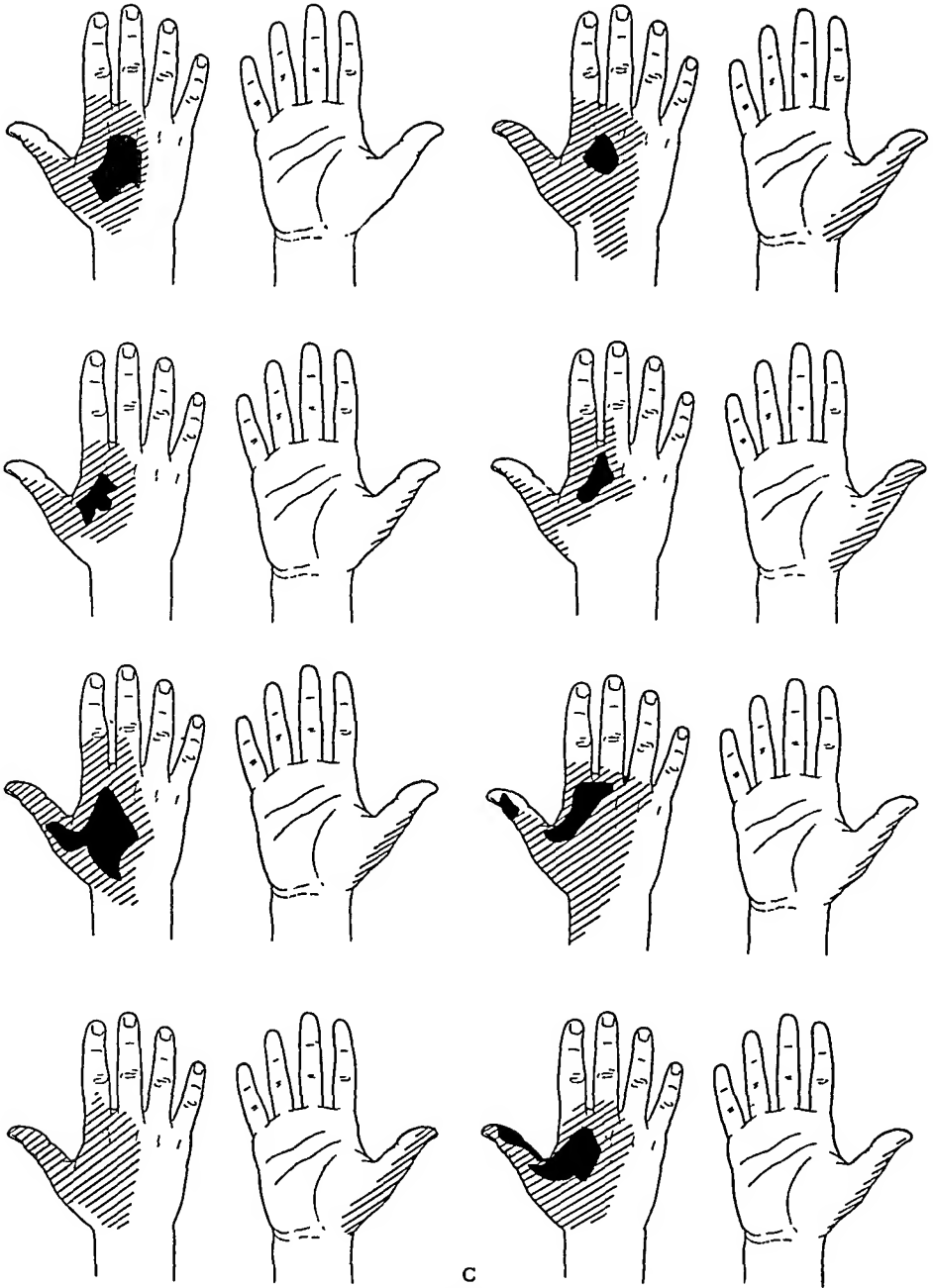
A
FIG. 64.

could be detected between the cases which recovered following neurolysis or resection and suture, except in those in which prior to the neurolysis the sensory loss did not occupy completely the sensory cutaneous distribution of the nerve. In the latter, very early return of function in the partly anesthetic or analgesic area was found.



B
FIG. 64.

[[611]]



c
FIG. 64.

The characteristic features of the sensory loss of regenerating nerves may be enumerated as follows:

Return of sensibility to pain, touch or temperature sense

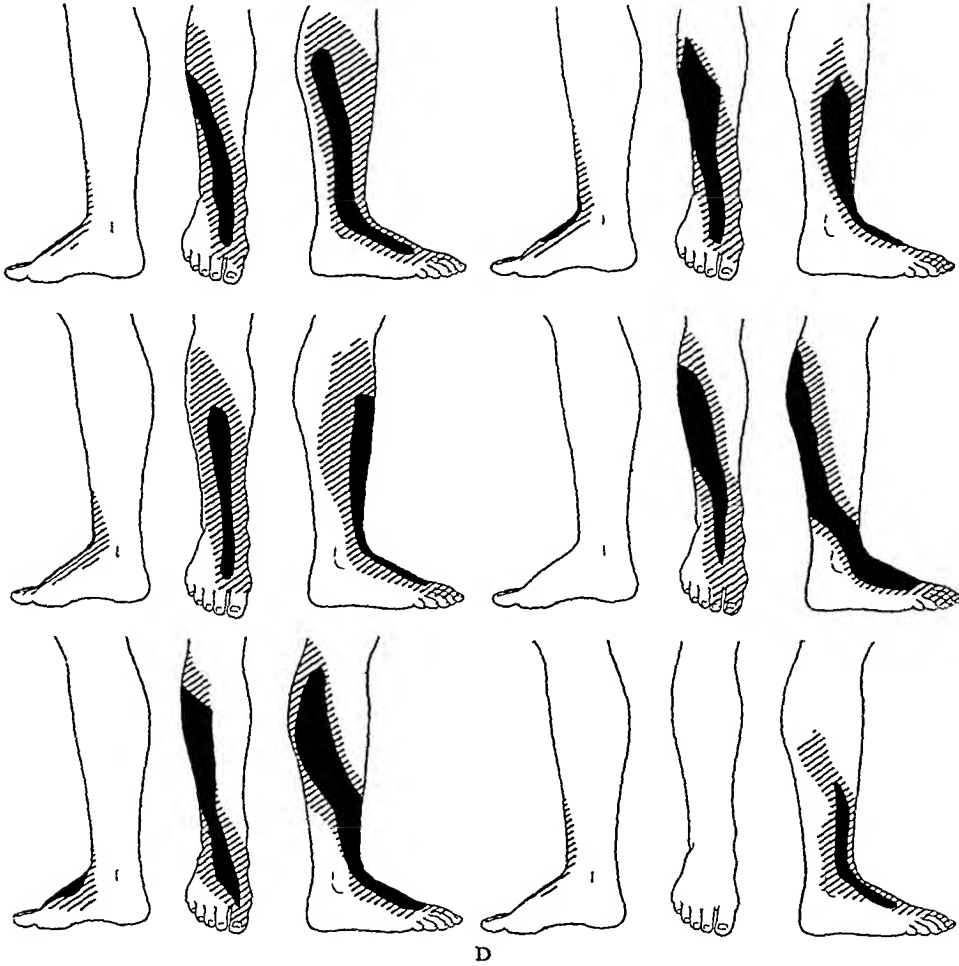


FIG. 64. Sensory loss in complete section of (A) ulnar nerve; (B) ulnar and median nerves; (C) radial nerve; (D) peroneal nerve. Note shrinkage due to nerve overlap.

in the isolated sensory supply of the injured nerve (Fig. 65).

Return of sensibility to pain, touch or temperature sense in patches some distance from the area supplied by an adjacent uninjured nerve (Fig. 66).

Return of sensibility to pain, touch or temperature sense in deep indentations (Fig. 67).

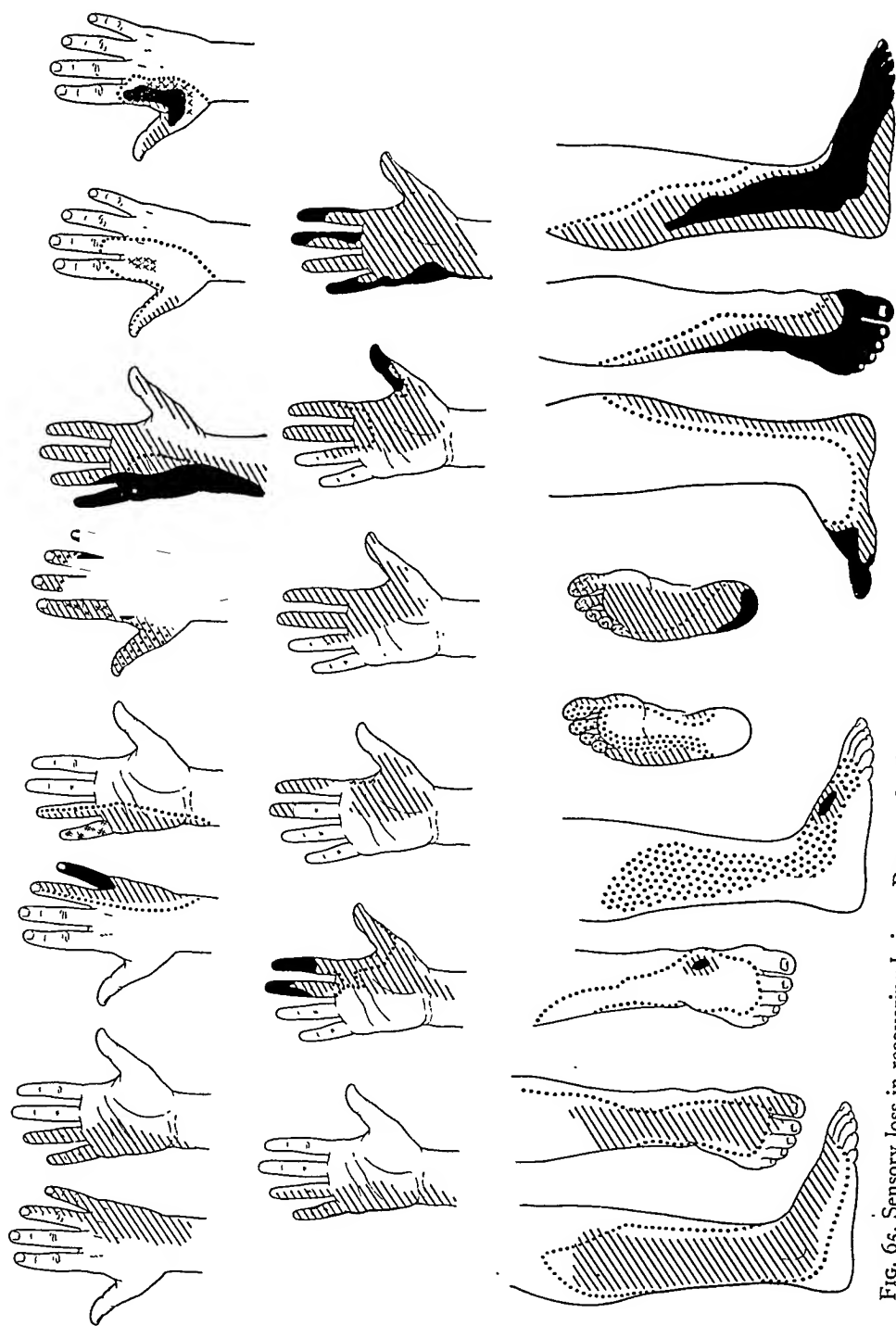


Fig. 65. Sensory loss in recovering lesions. Return of pain, touch or temperature sense in isolated supply of peripheral nerve.

Diminution of the degree of loss of sensation of pain, touch or temperature sense in the isolated sensory supply of a nerve (Fig. 68).

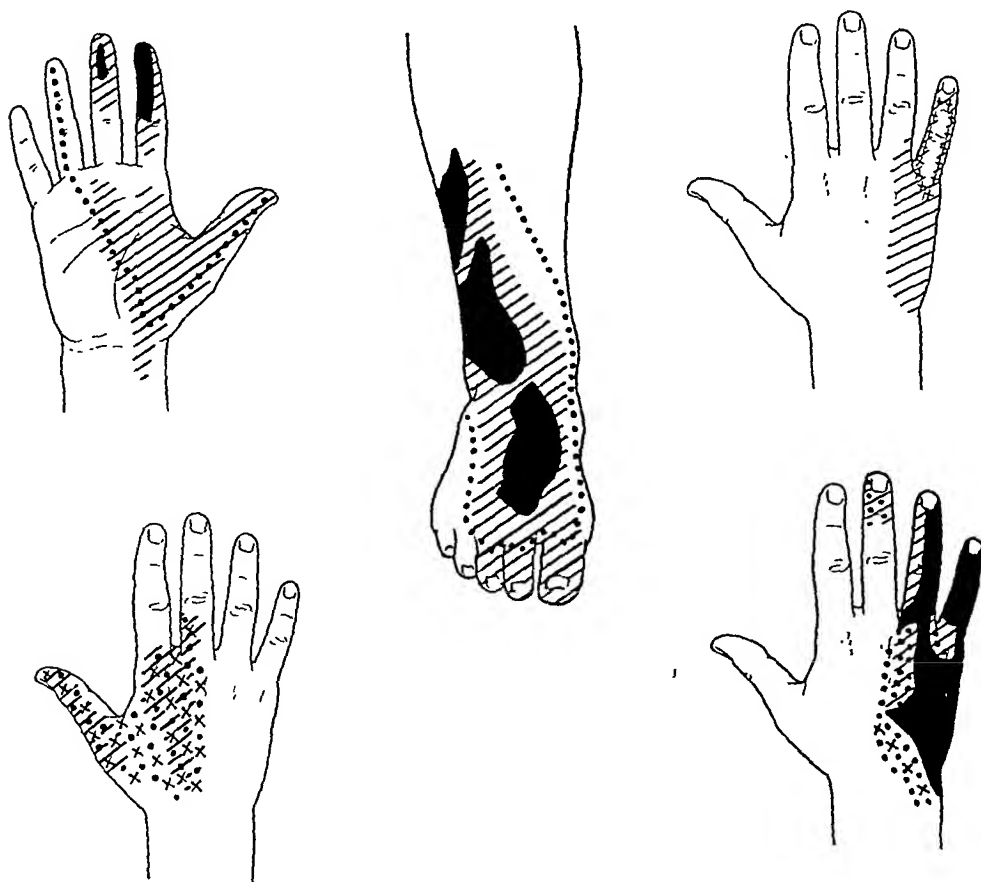


FIG. 66. Return of sensibility to pain, touch or temperature sense in patches some distance from area supplied by an adjacent nerve.

Return of sensation of pain, touch or temperature in the border between the sensory supply of two nerves simultaneously injured (Fig. 68).

Interlacing of the border of sensory loss of one type of sensation with that of another (Fig. 67).

ARREST OF MUSCLE ATROPHY AND RETURN OF TONICITY: These symptoms were not profitably employed in those cases which recovered some months after injury for reasons which have been already stated.

REACTION OF REGENERATION: It may be well to state that in the partial lesions which showed beginning recovery before the eighth month following injury, a response to faradism at

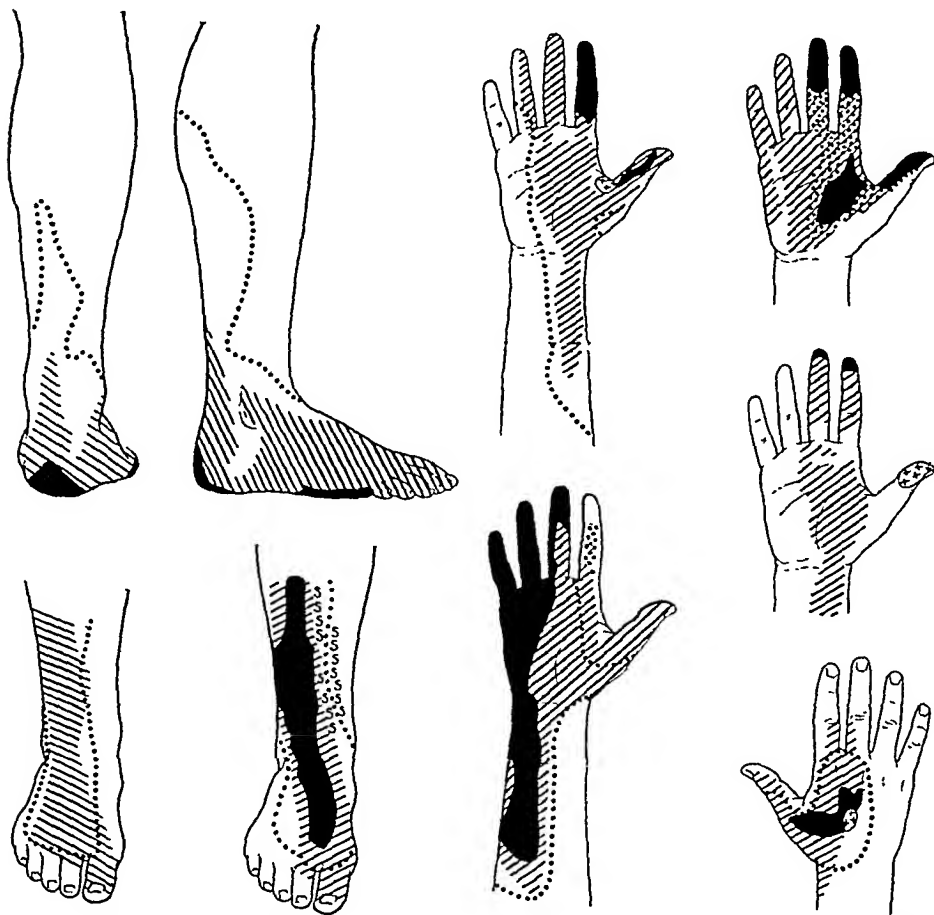


FIG. 67. Return of sensibility to pain, touch or temperature sense in deep indentations and interlacing patterns.

times returned before motion. At times motion was present and faradic response absent. The cases which showed beginning regeneration following resection and suture performed not less than six months following injury, never showed any return of response to faradism before the return of motion. The same is true of the cases which showed beginning spontaneous regeneration eight months or more after injury. In agree-

ment with Bénisty we found that faradic excitability of the nerve did not return before that of the muscle when percutaneous stimulation was used. The most reliable indication

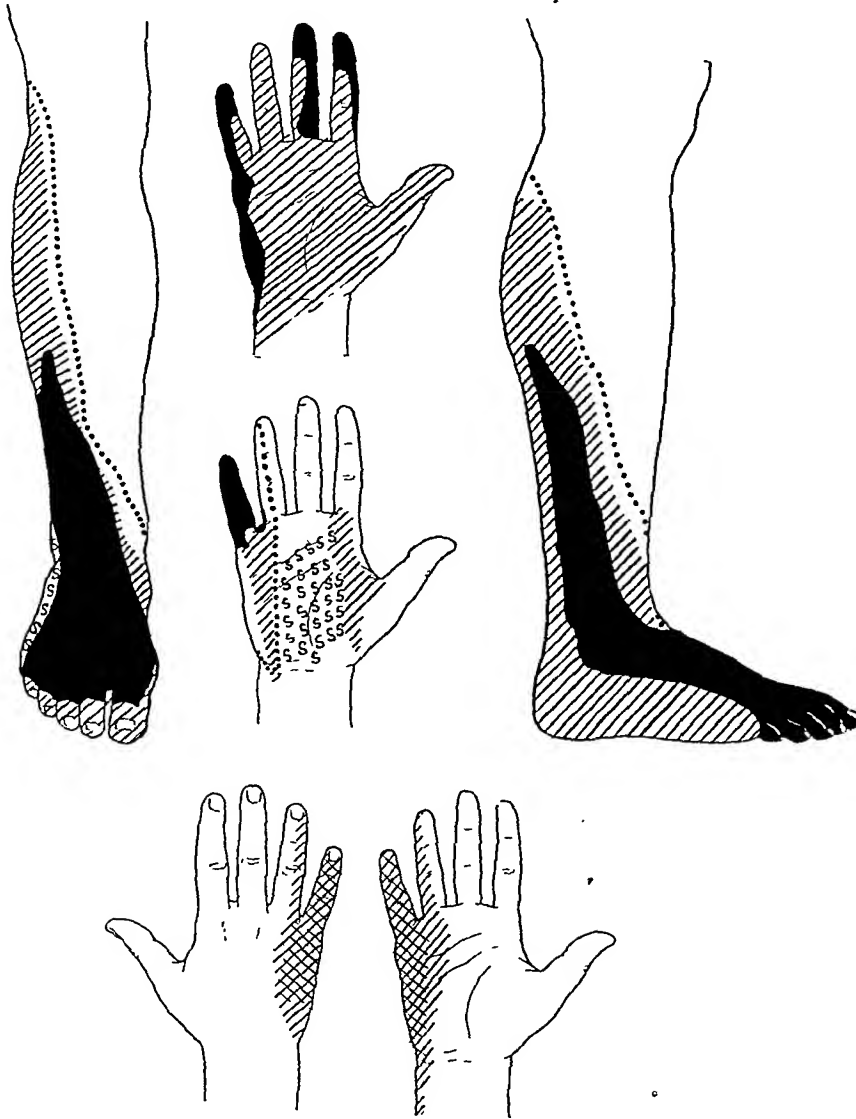


FIG. 68. Return of sensibility in zone between areas of two adjacent nerves and decrease in loss of pain in isolated supply area.

of recovery was an increase in the rapidity of the muscular contraction to the galvanic current.

RECOVERY OF VOLUNTARY MOTION: In the interpretation of the significance of the return of motion relative to regeneration, proper recognition must be made of supplementary motility.

The order in which movement is restored to muscles paralyzed as the result of peripheral nerve lesions has a sufficient constancy so that a clinical individuality may be attributed to each nerve. Generally speaking, in severe lesions a certain degree of muscular tonicity returns before any reappearance of voluntary motion, but the methods of measurement are so inaccurate that this statement is the result of an impression and the finding cannot be used in a prognostic sense. At first voluntary movements are awkward and uncertain and frequently the reaction time of a movement is considerably lengthened. Attention must be directed to what has been called "an error in the switching" of the motor fibers which have not taken the proper direction and have not encountered each time the sheaths intended for their reception. For example, when a patient suffering from an injury to his radial nerve wishes to extend his wrist the supinator longus contracts powerfully and often in excess of the extensor carpi radialis muscle.

At times it has been noted that preceding the ability to produce voluntary motion the patient experiences a feeling of being able to produce that certain motion when he wills it. For example, in a radial nerve lesion before recovery has taken place, the patient may not have been able to sense the feeling of extension, whereas when recovery is taking place he begins to feel the sense of extending the wrist, although such extension may not be produced.

In our experience, the order of the return of function in severe lesions has been sensation to pinching over the isolated supply of a nerve, at times spontaneous aching in muscles, return of motion, return of other objective sensibility, and finally a return of electrical excitability. Following injury the length of time necessary to observe the first sign of return

of function in a complete physiologic interruption of a nerve is variable. The earliest critical return of sensory and motor function is commonly five months. In other cases it has occurred eighteen and twenty-four months after injury. Following primary sutures, recovery is demonstrable in eight to nine months. In late sutures and in severe spontaneously recovering lesions evidence of recovery may not be seen until the eighteenth month.

CHAPTER XIV

DEVELOPMENT AND STRUCTURE OF THE PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system consists of groups of *nerve cells*, *ganglia*, bundles of myelinated and unmyelinated *nerve fibers* and specialized nerve endings. In addition to an anatomical difference the nerve fibers are physiologically dissimilar. *Afferent fibers* arise from cells of origin in the ganglionic crest outside the neural tube and carry sensory impulses from the periphery toward the spinal cord. The cells of origin of the *efferent fibers* are in the anterior horns of the grey matter of the spinal cord. These fibers carry motor impulses from the spinal cord to the periphery. Fibers of one or both types converge on each side of the spinal cord and form a *spinal nerve*. There is a pair of spinal nerves for each segment of the spinal cord.

The anlage of the entire nervous system is a thickened band of ectoderm, the *neural tube*, situated along the mid-dorsal line of the embryo. A groove is formed in this neural plate and later it is bounded laterally by paired *neural folds*. In turn these folds meet, fuse and form the neural tube from which all nervous tissue arises with but one exception. A longitudinal ridge of cells appears laterally where the neural plate and general ectoderm join. This is the *neural* or *ganglion crest*. Thus, when the neural tube closes and the general ectoderm separates from it the cells of the ganglion crest lie in a dorsolateral position to the neural tube. They later separate into right and left neural crests, distinct from the neural tube. Still later they take up a more ventral position and then this band of cells extends the entire length of the neural tube which now develops into the spinal cord. At regular intervals, or segments, of the spinal cord the neural crest cells proliferate, enlarge and form the *spinal ganglia*. (Fig. 69.)

The primitive *germinal cells* of the neural tube divide mitotically and form *ependymal* and *indifferent* cells. From the

indifferent cells *spongioblasts* and *neuroblasts* are formed. Spongioblasts develop into *neuroglia cells* and *fibers* and thus make up the supporting tissue of the spinal cord. The *neuro-*

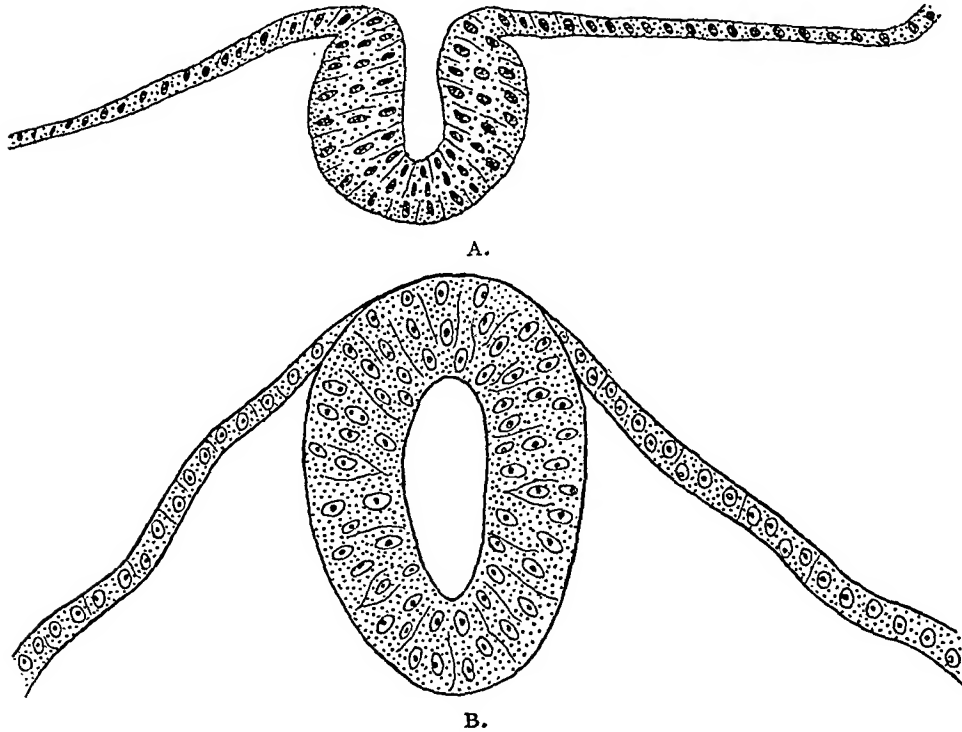


FIG. 69. Development of neural tube in human embryos (Arey); A, at 2 mm. (Mall); B, at 2.7 mm. (Kollmann).

blasts develop into nerve cells with an *axis cylinder* and *dendritic processes* and thus become *neurons*. The axis cylinders of the nerve cells in the anterior horns of the grey matter of the spinal cord emerge from the cord and form the *anterior roots* of the spinal nerves.

In a similar manner the cells of the spinal ganglia differentiate into *ganglion cells* and *supporting cells* comparable to the neuroblasts and spongioblasts of the spinal cord. The ganglion cells are pear-shaped and have a process at each pole. The process which is directed centrally enters the *posterior horn* of the grey matter of the spinal cord as the *dorsal root*. Within the spinal cord its collateral branches form a connection by

synapses with the dendritic processes of the nerve cells of the anterior horns. The peripheral processes of the ganglion cells join in a bundle and form the *posterior spinal roots*. As stated

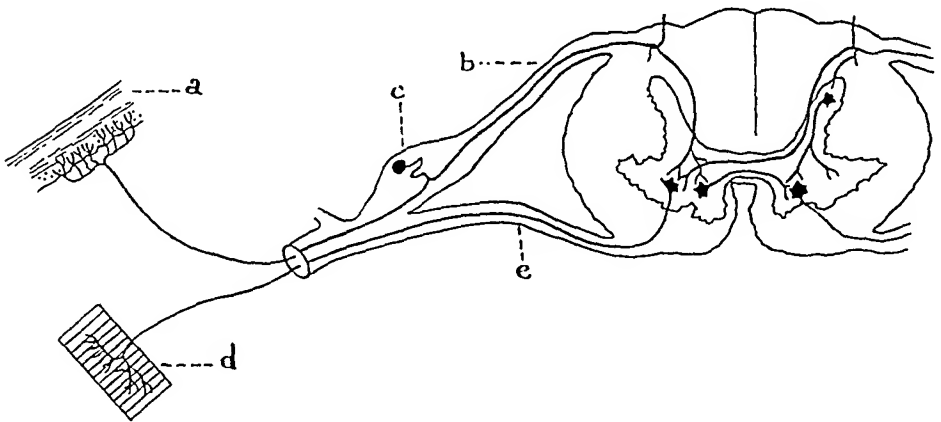


FIG. 70. Formation of a spinal nerve. a, Skin; b, Dorsal root; c, Spinal ganglion; d, Muscle; e, Ventral root.

before, the anterior and posterior spinal roots converge to form the trunk of the spinal nerve (Fig. 70).

NEURON DOCTRINE

The concept of the development of the spinal nerves given in the facts just presented has come to be known as the *neuron doctrine*. This doctrine assumes that the neuron is the structural unit of the nervous system and that axons and dendrites are outgrowths from nerve cells. Experimental evidence supports this hypothesis, originally advanced by His. Waller showed that if a nerve fiber is sectioned, that part distal to the point of section and separated from its cell of origin will degenerate. That part of the nerve fiber still attached to the cell will regenerate. Further evidence in support of this theory has been supplied by Harrison. He removed the ganglion crest from frog larvae and showed that no peripheral nerves developed. When the crest was transplanted to abnormal positions in the body of the embryo, it gave rise to nerves which followed paths where normally no nerves run.

A second theory (Heinsen's hypothesis) assumes that protoplasmic connections remain between a chain of cells. Some of these connections persist and differentiate into nerve fibers while the others disappear. This theory has been supported by Schwann, Balfour and Bethe and has been modified by Apathy and Schulze and by Held. It has not been widely credited.

The foregoing may be summarized as follows: the axis cylinder of a nerve fiber is the outgrowth of a single cell. It remains attached to this cell throughout. It grows from the center toward the periphery and establishes connections with an end organ. If any part of it becomes separated from its cell of origin, that portion degenerates.

HISTOLOGY

The supporting cells of the spinal ganglia at first form a syncytium which surrounds the ganglion cells but later they develop into flattened *capsule cells* which envelop the ganglion cells. They differentiate further into *sheath cells* and migrate peripherally with the nerve fibers of both posterior and anterior spinal roots. These sheath cells enclose bundles of fibers but soon proliferate and each nerve fiber becomes enclosed in a continuous sheath of cells. This is known as the *neurilemma* or sheath of Schwann. It is interrupted segmentally by constrictions known as the *nodes of Ranvier*, and each constriction represents the limits of one sheath cell. The neurilemma is extremely important in any consideration of the surgery of the nervous system. A neurilemma is not present about the fibers within the brain or spinal cord and section of the fibers in these locations is never followed by attempts at regeneration of the end still attached to the cell of origin. This is, of course, quite the opposite after section of the nerve fibers in peripheral nerves about which a neurilemma is present. Consequently it has been said that a neurilemma is necessary for regeneration after a lesion of the nervous system.

Within this outer covering, an inner *myelin* or *medullary sheath* develops about many but not all nerve fibers.¹ Hence, the division into *myelinated* and *non-myelinated* fibers, both of which have a neurilemma in a peripheral nerve. The myelin sheath is a spongy framework of *neurokeratin* in the interstices of which is myelin, a mixture of fats and lipoids. This substance plays an important part in the microscopic picture presented by a degenerating nerve fiber. The myelinated fibers have a glistening white appearance. This gives the characteristic appearance to the peripheral nerves. Non-myelinated fibers are present in abundance in peripheral nerves, however. It should not be forgotten that the myelin sheath and the neurilemma sheath are distinct structures and that both myelinated and non-myelinated fibers may have a neurilemma. Individual myelinated or non-myelinated nerve fibers may vary considerably in diameter. Their physiological function cannot be determined from their microscopic appearance. The proportion between myelinated and non-myelinated fibers within a peripheral nerve also varies considerably and as yet no relation between function and this proportion is clear.

Within a peripheral nerve the myelinated and non-myelinated nerve fibers are gathered together in bundles which vary in number, size and arrangement and give to each individual nerve a characteristic *internal topography*. The loose tissue which surrounds each entire nerve is the *epineurium* (Fig. 71). It consists of longitudinal bundles of connective tissue associated with elastic fibers and fat cells. It contains the nutrient blood vessels which supply the nerve. Each bundle of nerve fibers within the nerve is surrounded by a lamellar layer of connective tissue, whose flattened cells lie in contact so they form an almost continuous membrane. This is the *perineurium*. In the larger peripheral nerves prolongations of the perineurium extend into the nerve bundle between the

¹ The origin of myelin is in doubt. Ranvier believed it to be derived from the neurilemma. Kölliker regarded it as a product of the axis cylinder. Bardeen believes it to be an intercellular substance precipitated by the influence of the axis cylinder.

individual nerve fibers. These septa are known as the *endoneurium*.

Bardeleben's conception that although nerves are made up of

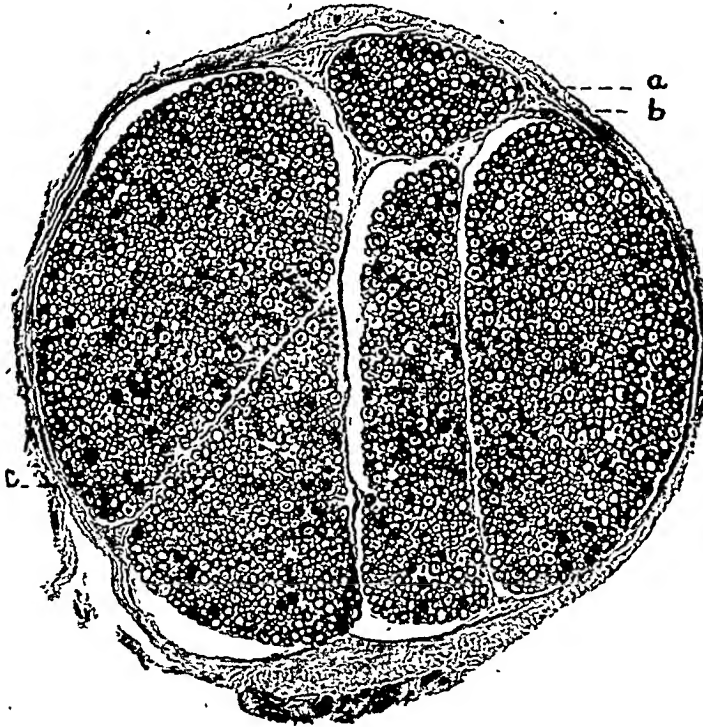


FIG. 71. Microscopic appearance of cross section of normal peripheral nerve. *a*, Epineurium; *b*, Perineurium; *c*, Endoneurium.

anastomosing bundles of fibers, the actual course of the fibers is a straight one from the plexus to the point of origin of a peripheral branch, was studied again in the material collected during the World War. Independently, in 1910, Stoeffel stated that the arrangement of the bundles, or *funiculi*, of nerve fibers within a peripheral nerve trunk were constant for that nerve at any given level. Thus, certain muscles or sensory areas innervated by a particular peripheral nerve are served by a funiculus of nerve fibers which occupies a definite circumferential position within the nerve at a given level. This view would indicate a very accurate funicular anatomy and the recognition

and observance of these anatomical facts would play an important rôle in the suture of divided nerve ends. Any disarrangement of the funiculi, such as the apposition of ends of sensory

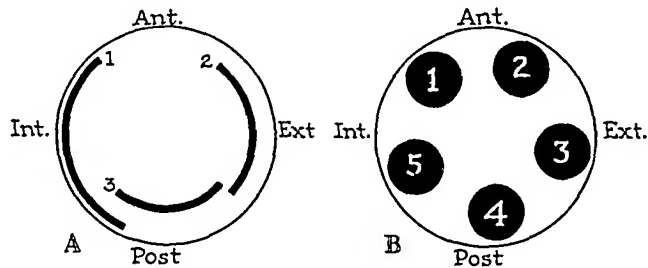


FIG. 72. Funicular topography of radial nerve.

A. (After Kraus and Ingham.) 1, Triceps; 2, Brachioradialis; 3, Extensor carpi radialis.

B. (After Stoeffel.) 1, Ramus superficialis; 2, Brachioradialis; 3, Extensors of the wrist; 4, Ramus profundus; 5, Supinator.

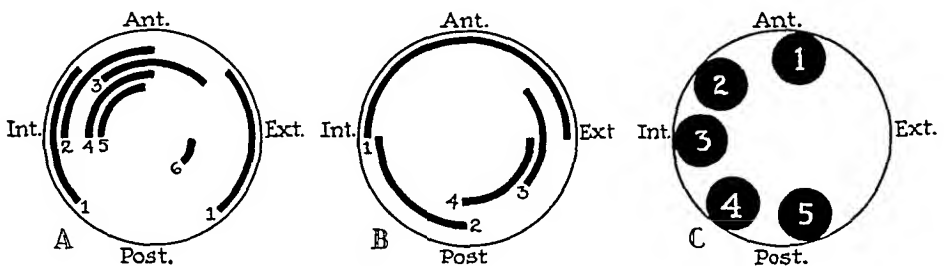


FIG. 73. Funicular topography of median nerve.

A. (After Kraus and Ingham) (Midarm level). 1, Pronator radii teres; 2, Flexor carpi radialis; 3, Palmaris longus; 4, Flexores digitorum; 5, Flexor pollicis; 6, Pronator quadratus.

B. (After Kraus and Ingham) (Midforearm level). 1, Sensory; 2, Opponens pollicis; 3, Abductor pollicis; 4, Lumbricales.

C. (After Stoeffel) (Arm level). 1, Palmaris longus, flexor carpi radialis and pronator teres; 2, Thenar muscles; 3, 4, Flexor digitorum sublimis; 5, Flexor digitorum profundus.

to motor fibers would impair the results of the surgical repair of nerve lesions. (Fig. 72.)

Marie, Gosset and Meige, Kraus and Ingham, and Putti have strengthened the view advocated by Stoeffel (Fig. 73). All of the experiments carried out by these men have been by the method of bipolar stimulation on the surface of nerve trunks exposed upon operation. Several serious objections to the results obtained from such experiments immediately

suggest themselves. (Fig. 74.) It would be difficult to obtain the same level on a given nerve for stimulation in different individuals. As a matter of fact, there have been shown to be marked

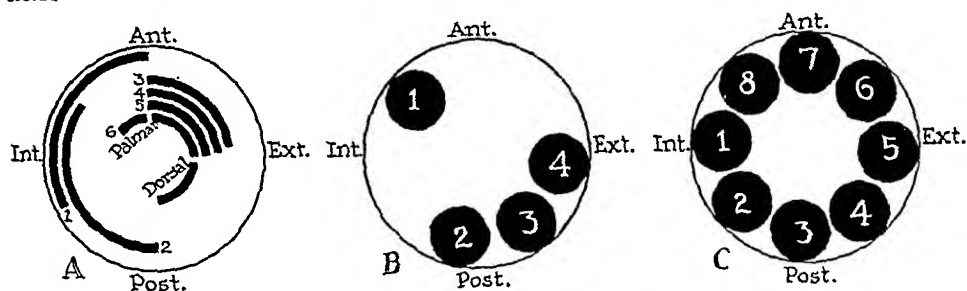


FIG. 74. Funicular topography of the ulnar nerve.

A. (After Kraus and Ingham). 1. Flexor carpi ulnaris; 2, Flexor profundus digitorum; 3, Hypothenar muscles; 4, Interossei; 5, Adductor pollicis; 6, Sensory.

B. (After Stoeffel) (Level of midarm). 1. Sensory fibers; 2, Flexor carpi ulnaris; 3, Flexor digitorum profundus; 4, Ramus profundus.

C. (After Stoeffel) (Level of midforearm). 1. Dorsal ramus to hand; 2, Ramus profundus; 3, Hypothenar muscles; 4, Interossei and lumbricales; 5, Adductor pollicis; 6, Deep head of flexor pollicis brevis; 7, Sensory fibers; 8, Ramus superficialis.

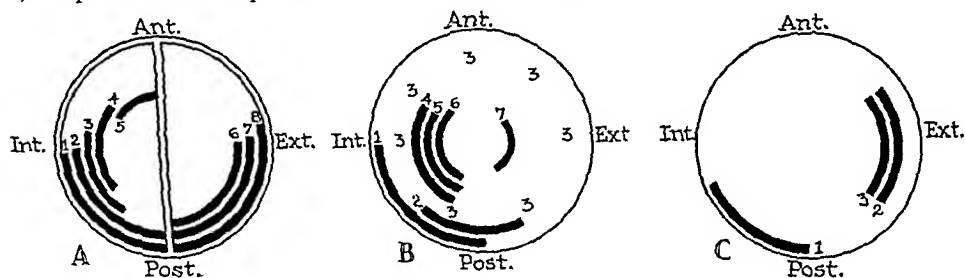


FIG. 75. Funicular topography of (A) sciatic nerve (after Kraus and Ingham); (B) tibial nerve, and (C) peroneal nerve.

A. 1, Hamstrings; 2, Gastrocnemius and soleus; 3, Flexor hallucis longus; 4, Flexor digitorum longus; 5, Tibialis posticus; 6, Peronei; 7, Tibialis anticus; 8, Extensors of toes.

B. 1, Hamstrings; 2, Gastrocnemius; 3, Tibialis posticus; 4, Flexor digitorum longus; 5, Flexor hallucis longus; 6, Intrinsic; 7, Flexor hallucis brevis.

C. 1, Peronei; 2, Tibialis anticus; 3, Extensors of toes.

variations in the same nerve on the opposite side in the same individual. The funiculi are so closely related to one another that the results of electrical stimulation upon the surface of the nerve would be difficult to attribute to a given funiculus in a definite quadrant. Finally, from a practical surgical standpoint, the recognition of the funicular topography by stimulation of the cross-section surface of a divided

nerve would be useless because of the degeneration in the distal fragment. The recognition of funicular topography in a peripheral nerve is only accurate for a given nerve at a particular level and at a definite time. Innumerable mechanical factors make impossible the stimulation of the same point at the same level on a nerve at different times. (Fig. 75.)

The acceptance of this theory would have a serious effect upon the future of the surgery of peripheral nerves. It has been denied vigorously by Heinemann, Borchardt and Wjasmenski, Langley and Hashimoto, Compton, Dustin, and McKinley. All of these investigators found the existence of innumerable internal plexuses within the peripheral nerves by which interfunicular connections are made. They also found that even at levels taken at intervals of 3 cm., the cross-section appearance of the nerve trunk was so different as to make identification of definite funiculi hopeless. None of these workers found that the funiculi constantly ran a separate and distinct course for any great distance.

While all of the facts brought out by the individuals who have investigated this matter are not in agreement in each case, nevertheless there are some unquestionable conclusions which should be borne in mind as far as possible in the surgical treatment of nerve injuries.

In the *radial* nerve there are two fasciculi which are quite definite. The fibers for the supinator longus occupy the external border of the middle third of the arm. The fibers for the extensor communis digitorum are placed upon the postero-internal surface of the nerve in the same area.

In the *median* nerve during its course in the arm, the fibers for the pronator muscles lie on the external border of the nerve while those for the flexor sublimis digitorum occupy the internal border. According to Stoeffel, fibers for the thenar muscles are intermingled with the sensory fasciculus. This group of fibers occupies three-fifths of the nerve trunk.

Intraneural localization within the *ulnar* nerve is more uncertain than in any of the larger mixed nerve trunks. Bénisty

states, however, that the fibers for the interossei muscles and the sensory fibers occupy the internal border of the nerve. The fibers for the deep flexors of the fourth and fifth fingers are located on the external border.

Only one group of fibers appears to be localizable in the *peroneal* nerve and that is the fibers for the *tibialis anticus* on the anteromedial side of the nerve.

In the *tibial nerve*, the posterior surface of the nerve is occupied by fibers which go to the *gastrocnemius* and *soleus* muscles. The fibers for the *flexor longus hallucis* are situated on the external border while those for the *tibialis posticus* are located on the anterior surface of the nerve.

NERVE ENDINGS

The nerve fibers which grow out from the anterior horn cells of the spinal cord and from the spinal ganglion cells have characteristic terminations which are known as *motor* and *sensory* nerve endings. Motor nerve endings terminate in smooth, cardiac and striated muscle and here we are concerned only with the latter. Sensory endings may be classified as:

1. Free endings.
2. Muscle spindles.
3. Tendon spindles.
4. Terminal corpuscles:
 - (a) Tactile.
 - (b) Genital.
 - (c) Bulbous.
 - (d) Articular.
 - (e) Cylindrical.
 - (f) Lamellar.

MOTOR ENDINGS: Neuraxons of the anterior roots form plexuses of medullated fibers in the perimysium of striated muscle fibers from which they extend into the muscle fasciculi. Each muscle fiber receives one and sometimes two of these branches. The connective tissue sheath of the nerve fiber blends with the perimysium and the neurilemma is continuous

with the sarcolemma. On the inner side of the sarcolemma the myelin sheath ends abruptly and the nerve fiber ramifies in a granular mass, which is probably modified sarcoplasm and

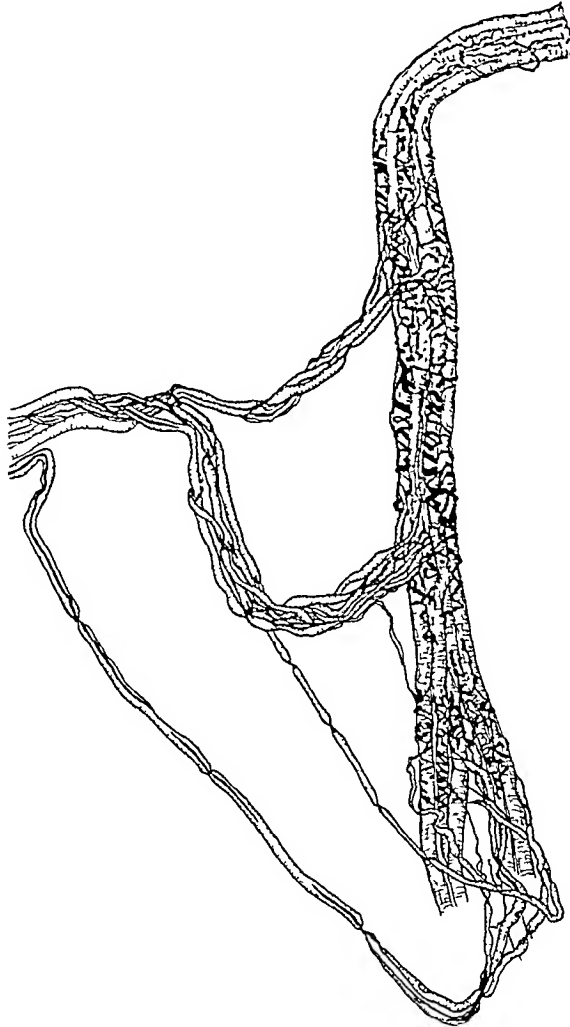


FIG. 76. Neuromuscular nerve end-organ from a dog. The figure shows the intrafusal muscle-fibers, the nerve fibers and their terminations, but not the capsule nor the sheath of Henle. Methylene-blue stain. (Huber and DeWitt.) (Ranson.)

which may contain muscle nuclei. This structure forms a distinct elevation which has received the name of a *motor end plate* (Fig. 76). Smaller non-myelinated fibers, independent of

the larger myelinated fibers, end in rings, loops or nets either within the sarcoplasm of a typical motor end plate, or as small independent end plates (Fig. 77).

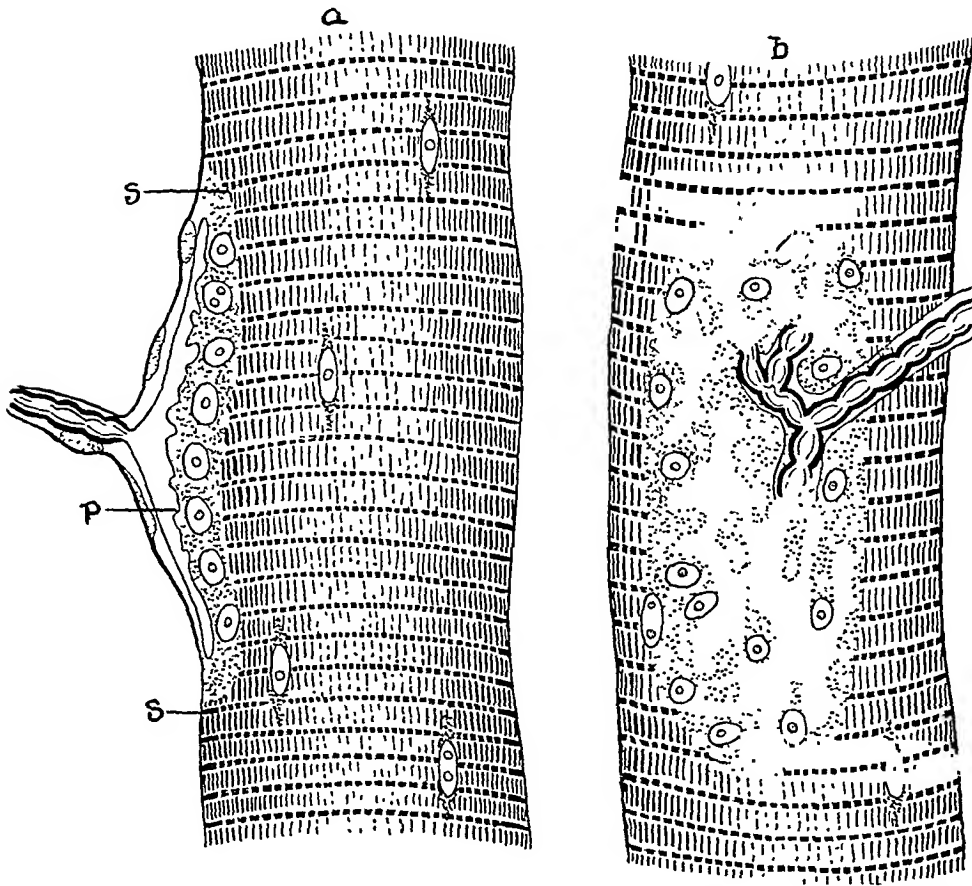


FIG. 77. Nerve ending in muscular fiber of a lizard. *a*, End organ seen in profile; *b*, from surface. *s*, Sarcolemma; *p*, Expansion of axis cylinder. Beneath this is granular protoplasm containing a number of large clear nuclei and constituting the "sole" of the end organ. In *b* expansion of axis cylinder appears as a clear network, branching from divisions of medullated fiber. (Kühne in Quain's Anatomy.) (Ranson.)

SENSORY ENDINGS: Free endings of sensory fibers to the epidermis and to the corneal and oral epithelia penetrate the basal layer and pass between the cells as unsheathed fibers. The extremities of the fibers are pointed or club shaped. They come in contact with epithelial cells but do not enter them. These

endings occur not only in stratified epithelia but also in muscle, tendon and connective tissue (Fig. 78).

Muscle spindles are slender groups of muscle fibers around

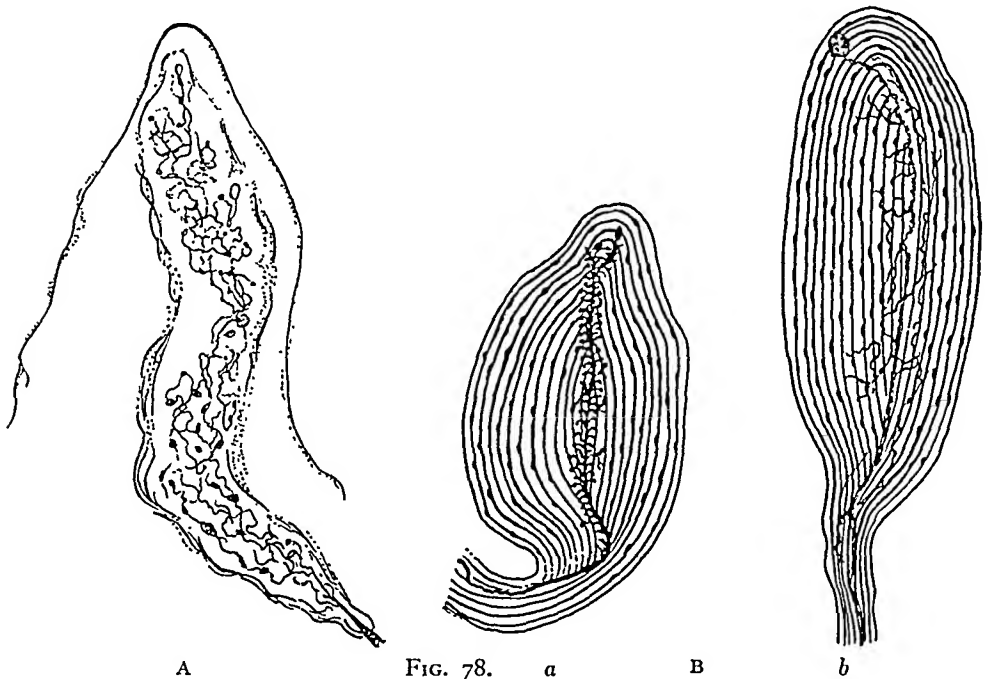


FIG. 78.

which nerve fibers terminate. The spindles are surrounded by a thick connective tissue capsule continuous with the perimysium. Three or four nerve fibers terminate in each spindle and their connective tissue sheaths blend with the perimysium. These fibers lose their myelin as they pass into the muscle cells. They may encircle the muscle fibers of the spindle to form spirals or rings.

Tendon spindles are small portions of the tendon enclosed in sheaths of connective tissue. The few nerve fibers which terminate in tendon spindles lose their sheaths, branch freely and end in club-shaped enlargements.

Terminal corpuscles are nerve endings which consist of a coarse nerve fiber surrounded by a semifluid intercellular substance and enclosed in a connective tissue capsule. *Tactile corpuscles* are elliptical in shape and contain several myelinated

fibers which enter the lower end of the corpuscle and immediately lose their myelin sheaths. They have a spiral course through the corpuscle. Tactile corpuscles are found in connec-

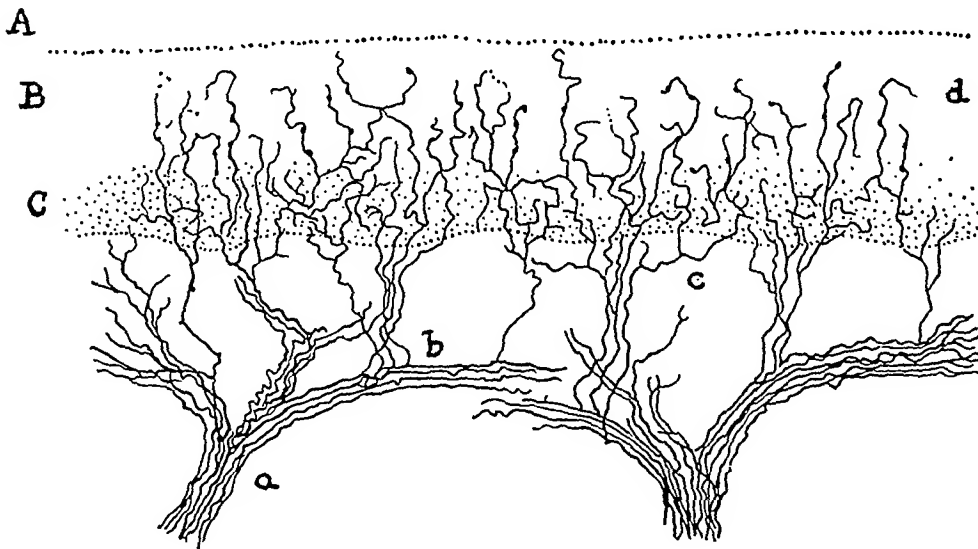


FIG. 78c.

FIG. 78. Types of sensory nerve endings.

A. Meissner's tactile corpuscle. Methylene-blue stain. (Dogiel, Böhm-Davidoff-Huber.) (Ranson.)

B. Pacinian corpuscles from mesorectum of kitten. a, Fine branches of central fiber; b, network of fine nerve fibers about central fiber. Methylene-blue stain. (Sala, Böhm-Davidoff-Huber.) (Ranson.)

C. Free nerve endings in epidermis of cat's paw. A, Stratum corneum; B, Stratum germinativum Malpighii and C, Its deepest portion. a, Large nerve trunk; b, Collateral fibers; c, Terminal branches; d, Terminations among epithelial cells. Golgi method. (Cajal.) (Ranson.)

tive tissue elevations just beneath the epidermis of the soles, palms and finger tips. *Genital* corpuscles are large round bodies which receive as many as ten nerve fibers. They are deeply placed beneath the epithelium of the glans penis, clitoris and adjoining tissues. *Bulbous* corpuscles are smaller, round or oval bodies with thin capsules and fewer fibers. They are found in the superficial connective tissue of the glans penis and clitoris. *Articular* corpuscles are found near the joints and are

similar in structure to the bulbous corpuscles. *Cylindrical* corpuscles contain a single nerve fiber, with few or no branches, which terminates in a rounded extremity. The fiber is surrounded by a semifluid substance which is enclosed in a few concentric layers of cells continuous with the sheath of the nerve. They are found in the mucus membrane of the mouth and in the connective tissue of muscles and tendons. *Lamellar* corpuscles are elliptical in shape. The axial core of the corpuscle is surrounded by concentric layers of a perineurium distended with fluid. A single large nerve fiber enters one end of the corpuscle and loses its myelin sheath. As it extends through the lamellae without branching it may become flattened and band-like or may divide at its terminal end and form a coil of branches. These corpuscles are found in the subcutaneous tissues of the hand and foot, near joints, in the periosteum, and in the connective tissue about large blood vessels and nerves and in tendon sheaths.

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